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Index

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Volume VIII DECEMBER, 1942 No. 4

CONTENTS

LET'S DO BETTER 97
The Editor
CERAMICS AND THE WAR 98
Henry G. Fisk
METALLIC LEAD PRODUCTS 99
Felix E. Wormser
THE HIERARCHY OF THE SCIENCES 102
Rev. Edmund J. Hamel
COLCHICINE-INDUCED POLYPLOIDY IN THE FRUIT FLY 105
D. C. Braungart and G. E. Ott
SCHOOL HOUSEKEEPING AND SCHOOL SUCCESS 106
Mary W. Muldoon
ENRICHED BREAD 108
Charles Hoffman
FIBERGLAS, A NEW BASIC MATERIAL 109
William H. Page
THE RATING OF EXAMINATION PAPERS IN SCIENCE 112
Ellis L. Manning
FREQUENCY MODULATION 114
Dwight A. Myer
WEEDS AS MEDICINES 117
Elbert Voss
NEW BOOKS 118
MORE QUESTIONS 132
COMING IN FUTURE NUMBERS 132
INDEX ..... Inside Back Cover

Let's Do Better!

In another place in this number appears a review of an inexpensive little book that contains the forty winning essays entered in the first annual Science Talent Search conducted jointly by Science Service and the Westinghouse Electric and Manufacturing Company. We call attention to the book again because reading it makes us regret that more Catholic high schools were not represented in the Search. We hope a greater number will enter future contests, especially since the national Duquesne University Science Essay Contest has been discontinued for the duration. Competition stimulates student and teacher and school. In this particular contest the material reward for the successful student is a considerable one.

Catholic schools are inclined to be too modest concerning their accomplishments and averse to calling attention to what they are doing. The writer is in a position to know what excellent science teaching is being done in many of our schools. It is fully equal, and often superior, to that found in the public schools of the same locality.

In the national Talent Search under discussion there were 3 200 contestants. We have no way of knowing how many Catholic high schools entered representatives, but no student from a school with a recognizably Catholic name is listed among the forty winners. Several are found among the 260 receiving honorable mention, but even here the number, comparatively, is far too low. Plainly there was a lack of entrants from Catholic schools. Perhaps the *teacher* was not interested. He should have been.

Let's do better next year! H.C.M.

Ceramics and the War

● **By Henry G. Fisk, Ph.D.,** *(Ohio State University)*
MINERAL TECHNOLOGIST, ARMOUR RESEARCH FOUNDATION, ILLINOIS INSTITUTE OF TECHNOLOGY, CHICAGO, ILLINOIS.

Attracting little attention because it does not employ energetic publicizers, one of the oldest of industries, ceramics, is nevertheless taking a very vital part in the war effort. Its field is broad, embracing all non-metallic minerals, but the industry is importantly concerned in the production of metals as well. Radio and electrical engineering find ceramic products indispensable.

In this short paper Dr. Fisk directs attention particularly to glass, enamels, and abrasives, and then gives briefer mention to several minor products. You will be interested to learn how military needs have stimulated the use of all of them.

●

A scientific industry as ancient as man yet as modern as today is coming into its own. It may yet prove to be one of the saviors of the American standard of living in this day when nothing short of an A-1 priority can buy even a tin can.

The industry is that of ceramics, which began as an art, rather than a science, centuries ago when primitive man first formed crude utensils from the clay around his aboriginal home. From the glazed figure which adorns the mantel to the cement blocks which form the business structure, ceramics have entered into a wide variety of phases of civilized living.

The ceramics of today is a far cry from those early clay dishes. Even before the War took metals out of circulation, ceramic raw materials were involved in 70 per cent of all industrial chemistry operations, they were fundamentally basic in the processing of most metals, and an integral part of such sciences as radio and electrical engineering. The most common base and acid in industrial chemistry are lime and sulfuric acid, both derived from non-metallic minerals. Without ceramic refractories, production of vital metals would halt.

Since Pearl Harbor imposed rationing upon the American scene, however, ceramics is daily becoming more important than ever and is well on its way toward a degree of importance it has not known since the advent of the metal age.

Modern ceramics, too, is a far wider science than mere clay modeling. In its broadest sense, it involves practically all non-metallic minerals. That is the basis for its special importance in war-time, for non-metallic minerals, along with plastics, are the only answer to the plaguing question of replacing the metals needed in war production.

Silicate products, principally glass, are the basis for a large portion of ceramic articles, glass for window panes as well as the precision mirrors and lenses of modern optical instruments, glass made into dishes said to rival fine eastern china in beauty. Glass jewelry is succeeding the metal costume jewelry of the past. And, now, glass is being put into use once again for food containers, and for shipping oil and other fuels. Modern improvements in annealing are making it practical.

Glass insulation was successful even before the war, but war's stimulus makes it almost a "must." Glass wool, for example, used in insulating a battleship cuts down the weight by some 50 tons. This type of insulation is fireproof and vermin-proof as well.

Another new use for glass is in marking airports and military highways. Tiny glass beads imbedded in the surface of markers reflect even a weak light into a guide for fliers or drivers of caravans.

Glass fibre is also in use for camouflage material. Light in weight, it can be placed easily on chicken wire, and it will support ice and snow. A further advantage is its non-inflammable nature.

A second common and fundamental ceramic product is enamel, which today is experiencing a come-back as a replacement for aluminum. Aluminum once replaced enamel in the manufacture of kitchen utensils, hospital instruments and other common containers, and gained immediate popularity because of its greater lightness. Today's superior enamels, however, placed over a stronger and thinner base metal, rival even aluminum.

Enamel has also been introduced as a lining for water and steam pipes and hot water heaters since copper has joined the list of vital metals. Enamels are also used on bricks and other construction materials to aid in withstanding the elements. Coal chutes of porcelain enamel now replace those of galvanized metal and are reported to stand up under usage better than the latter material.

Another fundamental use of ceramic products is for abrasives. The modern machine gun, for example, requires 32 different grinding operations before it acquires the needed precision for firing against the enemy. The abrasive wheels used in those grindings

(Continued on Page One Hundred and Thirty-one)

Metallic Lead Products

● **By Felix Edgar Wormser**
SECRETARY, LEAD INDUSTRIES ASSOCIATION, NEW YORK CITY.

The demands of the War have directed attention to our supplies of critical materials, especially the metals. This paper shows the important part lead plays in war, and its role in peace as well.

Mr. Wormser tells how metallic lead is worked, and then describes a considerable number of products that are manufactured of lead, such as cable sheathing, plumbing supplies, shot, solder and the other alloys that are now being substituted in products formerly made of tin.

This is the third and concluding article of a series. "Lead, a Basic Natural Source," appeared in Vol. VI, p. 78, and Vol. VII, p. 39.

●

Although chemical compounds of lead form one of the biggest outlets for the metal, even a greater total tonnage is manufactured into a wide variety of metallic lead products.

Lead is, for instance, rolled into sheets and foil, extruded into pipe, wire and other forms, cast, stamped and pressed into many shapes, and alloyed with other metallic and non-metallic elements for various purposes. We find lead alloys in the storage battery plates, ornaments and bearings of our automobiles, in solder, in the type from which this page is printed. The waste water from our plumbing fixtures may be carried away in lead pipe, and the flashings of our homes may be lead. The chemical industries depend greatly on both lead pipe and sheet to handle such corrosives as sulfuric acid and many others which violently attack most metals.

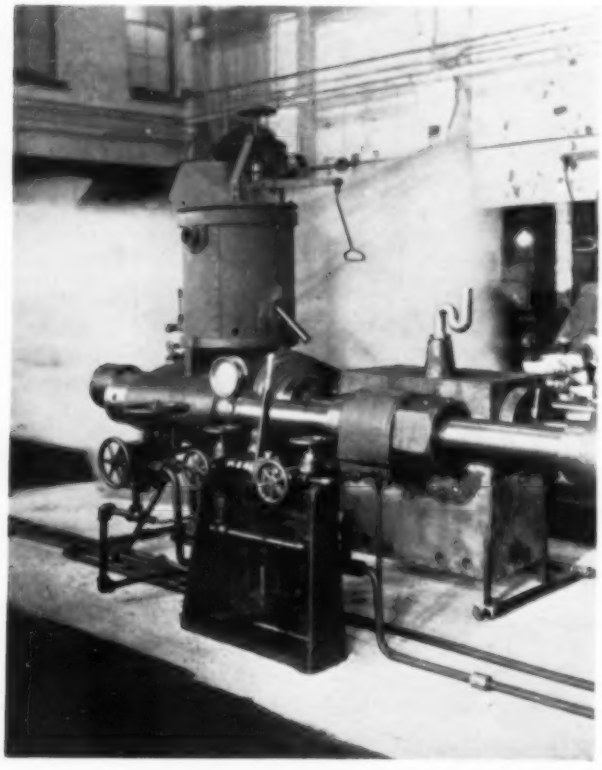
Sheet lead is rolled on mills up to 12 or 13 ft. wide. The lead is first cast into a slab about 4.5 in. thick, 10 ft. long and 4.5 ft. wide. Soft lead slabs are usually cast in open flat molds, but when lead alloy sheets are to be made, such as antimonial lead, the slabs are more often cast in vertical molds, jacketed and cooled to speed solidification and prevent segregation. These slabs are passed back and forth through the mill rolls, the rolls being set closer together after each pass, until the desired thickness is reached. The slab never gets any wider as it passes through the rolls, but it gets longer as its thickness is reduced.

The thickness of sheet lead is designated either in 64ths of an inch or by the weight of the sheet per square foot. This is because a square foot of lead 1/64 in. thick weighs almost exactly 1 lb. Thus 1 lb. lead is 1/64 in. thick, 8 lb. lead is 1/8 in. thick, 16 lb. lead is 1/4 in. thick. Above that thickness, the weight-thickness relationship does not hold so closely, 1/2 in. thick sheets being known as 30 lb. lead, and 1 in. sheets as 60 lb.

The extrusion process is used to fabricate many lead and lead alloy products. Among these are pipe, traps and bends, cable sleeving, lead and solder wire,

Installing sheet lead lining with lead welded seams in a tank to hold corrosive chemicals.

wedge lead for stone cutting, cames for leaded windows, and a great many specialties. Lead pipe is extruded from hydraulic presses exerting pressures of from 10,000 to 45,000 lb. per sq. in. At the top of the press is a cylindrical steel ram with a hole extending



Extrusion press used for making lead traps and bends showing a trap just completed.

through it from top to bottom. In the lower end of this ram, a changeable circular die, the size of the outside of the pipe to be made, is fitted. Below this is a cylinder into which molten lead is poured from the melting kettle. This cylinder holds, on the average, about 650 lb. of lead, but it may be smaller or considerably larger. After the lead in the cylinder has solidified, hydraulic pressure forces it up against the die and ram, the lead thus squeezing out through the opening in the die.

This however would make a solid rod. To make the hole in the center of the pipe, a steel rod, or core, the size of the inside of the pipe, is affixed to the center of the bottom of the lead-containing cylinder extending up through the center of the die. This leaves an annular opening between the core and die. The lead squeezes through this opening and comes out as seamless pipe. Since die and core may be changed at will, any diameter or wall thickness of pipe can be made. The same process is used for wire, but of course no core is necessary and a number of wires are extruded at one time, the die having several holes.

Extrusion of traps and bends is more complicated because of their shape, but the same principles are employed. The trap and bend press has two horizontal cylinders instead of one vertical. These cylinders feed to a die and core at the center between them. When pressure is applied to both cylinders equally, lead emerges through this die upwards in the form of straight pipe. When pressure is cut off on one cylinder, lead feeds more rapidly through the die from the other side, thus causing the pipe to bend toward the slow side. The bend may be reversed by reversing the pressures. It is, indeed, a weird sight to see lead emerging from this machine, bending first one way and then the other without apparent reason, since it is all controlled by small levers in the hands of the operator a few feet away.

Telephone and electrical cables are sheathed in lead by the same process with modifications. The press is similar to a pipe press except that the ram at the top is solid. Unsheathed cable is fed into an opening near the bottom of one side of the lead cylinder and emerges through a die in the opposite side, encased in lead. The die is thus in the side of the cylinder, the cable itself acting as the core, and the lead is forced out in the space between the die and cable.

There are a number of other variations to the extrusion process as used to fabricate lead products, but the foregoing paragraphs have described the major applications.

Drum traps, used mainly under bathtubs, are not made on the trap and bend machine. Pipe of proper diameter is extruded and cut to length. These short pieces are then placed on a lathe and one end is spun closed.

Lead wool is an extremely interesting product consisting of fine strands of metallic lead wound loosely into a rope. It is used for calking joints in cast-iron pipe, particularly under water or where inflammable gases are present, since it requires no melting or pouring. It is made by melting lead in an elevated kettle which has a nozzle at the bottom. This nozzle has a large number of small holes in it so that the lead runs out in a multitude of thin streams which solidify as they fall. They are caught in a sloping metal trough 8 or 9 ft. below, which gathers them together, and then are wound loosely into a rope.

At the moment, ammunition is a lead product attracting wide attention. In peace time, shot gun pellets are far more important than rifle bullets. Shot is made by pouring molten lead, alloyed with a small percentage of arsenic, through a sieve containing many small holes. The bottom of the sieve is covered with sludge so that the lead drips through slowly. As each drop falls, surface tension forms it into a sphere. The sieve is at the top of a tower and the shot falls into vats of water some distance below. The shot is then collected from the water and run over sloping glass tables with troughs at the bottom. The perfectly spher-

ical shot gathers enough momentum to leap the troughs, but imperfect shot is sufficiently retarded in its descent to drop into the trough and be rejected.

Large shot, like buck shot, is molded in automatic casting machines. These are vertical wheels with molds all around the rim. Lead is poured into each mold as it reaches the top, solidifies as it passes down one side, and the mold opens and drops the shot out at the bottom.

Lead containing up to 2.5 per cent antimony is used for rifle and machine gun bullet cores. These are made by first extruding into wire of the proper diameter, then cutting to length and swaging.

Storage battery plates are also made of a lead alloy usually containing between 7 and 10 per cent antimony and a small percentage of tin. These plates are good examples of the die-casting qualities of lead alloys since the plates are very thin and intricate. This alloy, however, makes excellent die-castings for this purpose.

The present emergency and consequent shortage of many materials has brought lead-base alloys to the fore. Although used for many years for certain die-castings where great strength was not important, the shortage of zinc has made it necessary to employ lead-base castings where zinc-base were formerly used. This was particularly noticeable in the automobile industry until its total conversion to war work, where lead alloys were substituting with great success for zinc alloys for die-cast ornamental parts. This same condition has led to considerable research recently on lead die-casting alloys, and new compositions, with advantages claimed over the old, have been developed. Type metal, usually an alloy of lead with tin and antimony, is another excellent example of lead-base die-casting metal.

Shortages of tin and copper have also resulted in a recent trend toward wider use of lead base bearing metals wherever feasible. These are of two types, one containing a high percentage of lead and small additions of tin, antimony and copper, while the other is almost entirely lead with only fractions of a per cent of such elements as calcium.

Soft solder is an alloy of tremendous importance and is usually composed of lead and tin. The composition varies depending upon the characteristics desired. Two of the most common solders are 50-50 tinsmith's solder, composed of half tin and half lead, and 40-60 or plumbers' wiping solder, which is 40 per cent tin and 60 per cent lead. The latter has a wide temperature range between the states of complete solidification and complete liquefaction. In this range, it is plastic and can be molded or "wiped." It is solder of approximately this composition that is used to join lead plumbing pipes and lead-sheathed telephone and power cable. Recent research, fostered by a possible shortage of tin in the emergency, has developed solder made up of approximately 97.5 per cent lead and 2.5 per cent silver. Although silver is more expensive than tin, so much smaller a percentage is used in this alloy that the cost of the solder is comparable to that of lead-tin solder, and silver is a domestic product, whereas tin must be imported.

In the packaging field, lead or tin-coated lead collapsible tubes and foil are common. Foil is rolled in much the same way as sheet lead except that the mills are much smaller. Lead foil may be rolled as thin as 0.0005 in. To produce lead foil coated with tin, sheets of tin and lead are placed on top of each other and rolled down to foil thickness, the pressure of rolling resulting in a firm bond between the two. Thus the lead may be coated on one or both sides, and the thickness of tin regulated by the relative thickness of the lead and tin sheets used.

Collapsible tubes for colors-in-oil, mucilage and other plastic substances are manufactured by stamping discs from sheets of lead of proper thickness. These discs are placed in small presses and drawn to the required length around mandrels. Tin-coated lead tubes for such substances as shaving cream are made in the same way, but the discs are stamped from lead sheets that have had tin sheets rolled onto them just like the sheets used to make tin-coated lead foil.

Lead is widely used as a coating material, usually for other metals, to add corrosion resistance to metals

G-E 115,000 volt single-conductor oil-filled submarine cable being reeled after application of lead sheath. For Columbia River crossing of the Northwestern Electric Company.

that might be attacked if left unprotected. Terne plate is a notable example. This is the material commonly known as roofing tin and is also used to form automobile gas tanks and other parts. It consists of steel sheets coated with an alloy of lead and tin, the aver-

(Continued on Page One Hundred and Twenty-three)

The Hierarchy of the Sciences

● **By Reverend Edmund J. Hamel, S.S.E.**
DEPARTMENT OF PHILOSOPHY, ST. MICHAEL'S COLLEGE, WINOOSKI PARK, VERMONT.

This paper will provide food for thought. Probably some will not grasp its full meaning at the first reading.

Is the grading of the sciences merely an academic question? How did the thinkers of the Middle Ages rank the sciences? What are the degrees of philosophical knowledge? What makes the study of metaphysics difficult? Are metaphysics, mathematics, physics and the special sciences autonomous in their own spheres? What causes contradictions between scientists and philosophers?

And, finally, is man "an upturned tree with hair for roots?"

●

The world is now going through a terrible crisis. We have reached a turning point in history, and as Goetz Briefs has pointed out (*Commonweal*, May 10, 1940), "In such periods of transition as ours, consciousness lags behind realities."

The need for social reconstruction is a universal cry. Everyone is aware that a new order is in the making; but to tell what sort of being will emerge would require the vision of a prophet. In spite of this, however, we should not forget that the kind of world we live in depends a great deal on the free activity of human beings. We are witnessing before our very eyes what one man can do to influence the course of history!

Here in America we are being deluged with all kinds of theories about the ways and means of saving our democratic way of life. If we ever expect to put order in chaos, to solve the problem of the one and the many in a way that will avoid the extremes of tyranny and anarchy in society, we must do hard and straight thinking.

Back of every movement in history there is a philosophy. First hatched in the abstract, it is sterile and does little harm there; but once it becomes incarnated in the souls of men, it lights up a veritable fire on earth. Witness, for instance, how Karl Marx's thought is living in Russia today. If we want to put order in our social relations, we must first of all put order in our thinking, and that, to my mind, brings out the importance of our subject, The Hierarchy of the Sciences. For if that problem can be settled we shall put order in our thinking, since the hierarchy of the sciences means the ordering of our knowledge.

Unfortunately, the subject is as difficult as it is important. In this paper we shall treat it concisely and only in its broadest outlines.

Let us remember at the very start that we are considering science in its broad sense, so as to include both wisdom, and science in the modern restricted sense. All science aims at certain, stable knowledge through causes or reasons, and this implies the science of the universal in things. There is no science of the particular as such; *e.g.*, the biologist is not interested in this particular cell so much as he is in the cell. If he were to rivet his attention on the particular in the cell, he would spend his whole life on that one cell and he would get no knowledge that would help him to study other cells, for an individual, as such, is incommunicable and there can never be a reproduction of it in nature. In technical language, when the science study of an object reaches only the proximate cause or reason, we have science in the strict sense; but if it reaches to the ultimate causes or reasons of each and every thing we have wisdom, which is the highest and most perfect form of science.

Put in general terms our problem might be worded: The ordering of wisdom and science; or, if you wish, What is the relation between the two? Are they identical or are they different? If they are different, how can they be united? Are they of the same level, or is one on a higher level than the other? These are some of the questions that we ask ourselves at the first approach.

There are two extremes we must avoid:

1. Doing away with all differences by reducing all the sciences to one and essentially the same kind of science. That would solve the problem by destroying the autonomy of the several sciences, and that kind of unity would only breed confusion and disorder.

2. Breaking the unity by divorcing all the sciences and putting them all on the same level. That would be anarchy, and would likewise breed disorder and confusion. We must not, like Descartes, divide in order to separate; but, as St. Thomas did in theology and philosophy, distinguish in order to unite.

The problem of the hierarchy or grading of the sciences is but a particular application of the problem of the analogy of being. We must remember that science is an analogous concept; *i.e.*, one that is realized differently in different objects and allows for the existence of essences that are totally different. We must avoid univocity and equivocity in the predication of the term *science*. To put the case in more concrete terms, if we make science a univocal concept, we must reduce all the sciences to one and essentially the same science,

and that is dictatorship. If we make it an equivocal concept, we must divorce all the sciences and destroy all the relationship between them, and that is anarchy.

If we make it an analogical concept, we allow for their differences and at the same time keep their unity. They are all science, but this one in its own way, and that one in its own way, and that is democracy in the scientific world. But there is order in democracy. The functions are not all of the same level. Neither are the offices, and everybody cannot be president. There is one president, and a gradation down all along the line. As M. Maritain pertinently remarks:

> "An army in which anybody may be a general is not the army of democracy, but of stupidity. A republic of knowledge in which each type of knowledge claimed for itself the architectonic rank, or where it was declared that no one body of knowledge had a higher rank than any other, or a superordinate regulative role, would be a republic of ignorance." (*Science, Philosophy, and Religion*, page 179.)

There was a time when the hierarchy of the sciences, at least of the wisdoms, was not merely an academic one, but a living, vital fact. That was during the Middle Ages.

The Middle Ages were deeply conscious of a fact that the modern world has lost sight of, namely, that man is *de facto* established in a supernatural order. Their world was Christo-centric, and their natural wisdom was constantly illuminated by Divine Wisdom in the concrete by God's Wisdom in the flesh. That is the wisdom that our modern world must again contact if it wants to become sane again, and be Christian in deed as well as in name. Accordingly, at the top of the ladder was placed mystical theology, that wisdom which is supernatural in root as well as in method, and which gets scientific knowledge through the loving contemplation of God.

Next came discursive theology, a form of wisdom supernatural in root, *i.e.*, the starting principles are revealed truths, but human in method, acquired by the natural reasoning of man enlightened by Faith. These two wisdoms were considered the highest and surest types, because their cause is the most stable and the most certain, God Himself.

Then in order came metaphysics, mathematics, and physics. Philosophy looks for the ultimate causes or reasons of all things. Hence by abstraction—a process that is necessary for all the sciences—it looks for an intelligible object, mark I say *intelligible*, which is common to all things. Needless to say that object is "being," for the object of man's intellect is what is, or can be. And here it might be well to remark that what distinguishes philosophy from the particular sciences is *being*. Philosophy is on the chase for being. The particular science is on the chase for the phenomena of being. Now the Scholastics, following Aristotle, graded their three branches of speculative philosophy according to the three degrees of abstraction.

If we look at "what is," the first common trait that strikes us is *change*. If we omit consideration of the individual traits that make material beings individuals, we are left with being as invested with common sensible material traits and subject to change, *ens sensibile* the scholastics called it, and this object was treated by the old physics, or the philosophy of nature; today it is called cosmology and psychology. Notice that in this degree of abstraction, the intellect is beginning to get a peek at its intelligible object, being, but the object is yet clouded with matter. The mind can go a step further in abstraction and leave out of consideration the common sensibles (qualities grasped by the senses) as subject change, the quantity, or, better, being as quantified. That object was treated in the old philosophy of mathematics. There is hardly anything of it left today, except a few concepts treated in cosmology or metaphysics. Notice that being is becoming more intelligible, for it is losing its material density.

Finally, the mind may leave out of consideration even the quantity; and then it is left with being as such, being as being, being in its full intelligibility and mystery. That object was treated in metaphysics, first philosophy, or ontology as it is called today. In the first two degrees of abstraction the sun of intelligibility, being, was more or less eclipsed. In the third degree the eclipse has gone and being shines out in all its brilliancy.

Mr. Maritain gives a beautiful description of the three degrees of philosophical knowledge:

> "If it is permissible to make use of figurative language, one could say that the work of the intelligence could be compared to an immaterial magic. From the flux of singular and contigent things apprehended by the senses, the first glance of the intelligence evokes the world of corporeal substances and their properties: a second glance evokes another universe, the ideal world of extension and number: A third, yet another different world, the world of being as being and of all the transcendental perfections common to both bodies and spirits, where, as in a mirror, we may attain to purely spiritual realities and the principle of all reality." (*Degrees of Knowledge*, p. 47.)

Before taking up the analogy of the above division, it may be well to remark here that what little there was of the special sciences during the Middle Ages was studied under physics or the philosophy of nature. Unfortunately, the philosophy of nature and the sciences were not distinguished, and this led to a divorce between the two.

Now the division of speculative philosophy into physics, mathematics, and metaphysics is not a division of a genus into its species. It is a division of three different orders of genera; in short, it is an analogical division. In his commentary on the Trinity of Boethius (p.5.a.2) St. Thomas explains *that* very clearly. After asking whether the imagination should be left aside in the consideration of divine, i.e., metaphysical realities, he goes on to say,

> "I answer that it must be said that in any knowledge whatsoever two things must be considered: the principle, and the end or term, (i.e., where it comes from and what it ends in). The principle belongs to the act of simple apprehension, and the term or end (i.e., what the judgment is verified in or leads us to) belongs to judgment, for knowledge is perfected in judgment."

He then goes on to show that the principle or source of our knowledge is always the apprehension of sense, i.e., sense knowledge, but that the term of our knowledge is not uniform, for sometimes it is verified in the sense, sometimes in the imagination, and sometimes in the intellect. A judgment in the philosophy of nature must be verified in what the senses perceive, a judgment in mathematics is verified in the imagination, and a judgment in metaphysics is verified in the intellect. A mathematical judgment is above the apprehension of sense, and a metaphysical judgment is above the apprehension of both the sense and the imagination. (That is what makes metaphysics so difficult; we can no longer think in pictures.) "And," concludes St. Thomas, "*Propter hoc peccant qui uniformiter in tribus his speculativis partibus procedere nituntur*"—"on account of this, they commit an intellectual sin who endeavor to proceed uniformly, (i.e., use the same method) in the three branches of speculative philosophy," and, we might add, in the natural sciences.

This passage gives the solution to the crux of the question we are discussing. It means that metaphysics, mathematics, physics, and the special sciences are autonomous in their own spheres. The metaphysician who tries to use the method of metaphysics in the solution of a problem in a special science is bound to end in failure and to irk the scientist. On the contrary the scientist who denies metaphysics because he cannot bring it within the scope of his science is just as silly and is likely to peeve the philosopher, and the mathematician or the physicist who tries to reduce metaphysics to a mathematical or a physical concept distorts or destroys metaphysics and has a mathematics or a physics. In the study of a single cell, there is the point of view of philosophy, of mathematics, of physics, and of special science, and those points of view should harmonize. If they do not, it is not because of a contradiction between philosophy and science, but of a contradiction between a philosopher and a scientist, and there is a *toto coelo* difference between the two sets of terms.

So far, the autonomy; but what about the unity?

I shall quote a rather long passage from M. Maritain on this point:

> "Let there be no misunderstanding here. Each scientific discipline is free in its domain and develops autonomously: That is clear, because by definition, it alone is competent, regarding its specifying object. Thus, when we say that philosophy is of a higher order than the sciences of phenomena, we do not mean thereby, that philosophy can enter into the realm of these sciences and wilfully decree what is true and what is false; it is not fitted for that. The confusion and tragedies caused during the Renaissance by a theology that wished to prevent the earth from turning and by a decadent Aristotelianism which decreed that it was wrong for the telescope to show spots on the sun, have put the scientific world on guard most rightly against all dictatorship of this kind. What we do mean is that philosophy occupies a higher plane in the edifice of knowledge because its object or purpose, which is concerned with primary causes, reveals to it, realities that are more profound and more essential. This diversity of planes, superordinate to each other, is the basic condition for the autonomy of each order of knowledge. If all the disciplines, diverse in essence hunted in the same fields, they would inevitably limit each other and collide, ending in a condition which would soon be chaos. But because in reality, each develops upon a distinct plane, each may progress to infinity upon this plane without ever meeting the others. The biologist may progress endlessly in the knowledge of the human being from the standpoint of its physiological and physico-chemical functions without ever coming into conflict with the philosopher who progresses, on his part, in the knowledge of human being from the standpoint of the relation between soul and matter.
>
> "In what sense, however, do we say that the disciplines of a higher rank have a regulating or architectonic role as regards the others? We mean by that three things: First, it is the metaphysician, for instance, who must know and justify the principles of the other sciences; not the mathematician but the metaphysician must examine the value of the principle of non-contradiction, or ask himself what constitutes the essence of quantity.
>
> "In the second place, it pertains to those disciplines whose object is more profound and more universal to prevent the mind when it works in disciplines of less elevated rank, from over-stepping the objective limits of these disciplines and falling into errors foreign to them. Thus, the paleontologist does not step out of his sphere when he establishes the hypothesis of evolution and applies it to the origin of that human being. But the philosopher must warn him that he is out of his field, when he tries to deny for that reason that the human soul is a spiritual soul which cannot emanate from matter, so that if once upon a time the human organism was produced by a mutation of animal organism, it was because of the infusion of a soul created by God.
>
> "Thirdly, the disciplines of wisdom protect the other disciplines against the hidden domination of unconscious metaphysics, and in that way safeguard their liberty and their autonomy. For instance, it would be difficult to show, along with Mr. Bergson, that the mechanistic bias and the doctrine of psycho-physical parallelism which have so long fed parasitically upon modern physics and modern psychology, were, all unknown to themselves, in reality of metaphysical origin and arose from the unconscious domination of Spinoza's philosophy, which was automatically accepted without critical scrutiny. And it would be easy to multiply the number of such cases." (*Science, Philosophy, and Religion*, p. 179 ff.)

We have already given some examples of false concepts of particular sciences during the Middle Ages. Here are some examples of the condition of science about 1200, in some quarters at least. They are taken from *De Natura Rerum* by Alexander of Neckam.

(Continued on Page One Hundred and Twenty-five)

Colchicine-Induced Polyploidy

In the Fruit Fly

● **By D. C. Braungart and G. E. Ott**
DEPARTMENT OF BIOLOGY, THE CATHOLIC UNIVERSITY OF AMERICA, WASHINGTON, D. C.

In recent years colchicine has been used by many workers to induce polyploidy in plants, but the authors of this paper are probably the first to use this drug to induce polyploidy in animals.

They devised several series of experiments whereby colchicine could be applied to different stages in the life cycle of the fruit fly. The most important single effect observed was the production of small but definite polyploid areas in the brain tissue showing an increased number of chromosomes.

This research is important both in itself and in the possibilities it opens for future study and accomplishment.

●

An attempt was made to induce polyploidy in the cells of Drosophila Melanogaster, the fruit fly, by treatment with an alkaloid called colchicine.

This investigation was limited to a study of mitosis in the brains of the larvae of this genetic animal. A set of experiments was devised and the brains dissected out of the treated animals. Slides were then prepared and studied for the purpose of detecting any effect that the drug might have.

Colchicine, from work done by Blakeslee and others on plants, has been known to produce polyploidy. This drug has a peculiar effect on cells undergoing mitosis. It apparently inhibits the division of the cell but allows the chromosomes to divide while exerting its effect. This fact will then allow for an increase in the chromosome number of such a cell. A polyploid cell undergoing mitosis may produce cells which exhibit this new chromosome number.

Such information stimulated the present study. It was hoped that a truly polyploid animal could be produced in that way. This, however, was not the case as the results show. Even in a study of a small part of the animal, namely the cells of the brain, it was not possible to induce all the cells to become polyploid. The result was that only specialized parts of the brain exhibited what we hoped to find in the entire animal.

One of the most successful methods used was the injection of a .0013% solution of colchicine into the body of the larvae. By means of a Number 27 hypodermic needle, filed down somewhat and attached to a long rubber tube used as a syringe, a small amount of the body fluid of young experimental larvae was drawn out and an equivalent amount of the drug injected back into the body in the region of the brain.

The treated larvae were then allowed to continue their development after exposure to the drug for from 2 to 20 hours. After treatment, the larvae were placed under a microscope and the brains removed with a pair of dissecting needles. These brains were then stained with aceto-carmine and prepared for study.

The most important single effect was the production of polyploid cells in specific areas of the brain. The chromosome number was increased from 8, which is the normal number for these flies, to 16 and 32 as observed in some of the cells.

Some larvae were allowed to continue their normal growth period. Of that number many reached the pupa stage but only after a much prolonged larval period. The normal larval period is from 5 to 6 days at the temperature which was maintained in the control room. After treatment with colchicine this period was increased in most cases to 7 days and in some as long as 11. None of these pupa reached maturity and the effect of the colchicine was very likely responsible.

What significance this has for future experimental work remains to be seen. It does open up an avenue for further investigation. The results obtained with the fruit fly coincide with the effects this drug has on plants. It is hoped that the same progress can be made in the animal kingdom as has been made in the botanical studies. ●

The Scientist

"Of course no scientist can be continuously aware of the remote possible consequences of his labors; in fact the long goal is so remote that if he kept his eyes on it he would become hopelessly discouraged over the half inch of progress his own life's work will represent. But it was the vision of this which first made him choose his curious career, and it is an emotional sense of the great structure of scientific knowledge to which his little grain will be added which drives him along."

OLIVER LAFARGE
Harpers Magazine, Nov., 1942.

School Housekeeping and School Success

● By Mary W. Muldoon
PRINCIPAL, JUNIOR HIGH SCHOOL, WAVERLY, N. Y.

Are you a poor school housekeeper?

In matters of school routine do you talk too much?

Have you learned to organize, systematize, automatize?

Here an experienced executive discusses the routines that can and should be established in every classroom where students of junior high school age and younger are taught. Some excellent time savers are mentioned.

How does your schoolroom look? After you read this article you will probably see it with different eyes.

●

"Man works from sun to sun, but woman's work is never done."

When this is true, it is usually because that woman works with her hands instead of her head. It is also true that the over-worked young teacher frequently doesn't need sympathy; what she lacks is system. Whose? One of her very own. She should look over her own situation impersonally and work out her own salvation, but the experienced teacher can often offer suggestions that will hasten the process.

The first suggestion is this: *School housekeeping is an important factor in success.* School housekeeping is so important that often your superintendent does not need to visit your classes, if he is in a position to glance into your room after dismissal.

At what is he looking?

He is asking if your bookcase is an orderly storehouse, or a catch-all. Either is an indication of your method of thinking. What about a systematic arrangement of the top of your own desk? It reflects your thought patterns, doesn't it? Are the front seats loaded with disorderly piles of books? Is your bulletin board ragged with fluttering papers askew in every direction, or is it an orderly showroom with something of value to sell? Seen from the back of the room, are the students' desks stuffed with a conglomeration of papers like rats' nests, or are they neatly arranged, tidy, orderly storage spaces, with everything in its own place?

(Might there be a valuable training in requiring students to police the contents of their own desks daily, possibly even in insisting upon certain specified arrangements in the lower grades? We do this in the domestic science kitchens, and train the workers into a respect for orderly arrangement in a short time.) Is your own desk drawer fit for inspection? Have you a definite place for keeping your plan and report books, known to the supervisor, and easily accessible in case of emergency? Are the curtains straight when you leave at night? Are the boards erased, erasers in position, crayon collected? Is your floor free from papers? Have you suggested to the students that they could assist the janitor by turning up their seats at dismissal? Do they do this?

Caring for every one of these items need not take more than 45-60 seconds daily. If, the first day of school you elect or appoint, whichever seems better, a Clean-up Committee which should include practically every one in the room, each to take care of one definite tiny portion of the work for which he is personally responsible, the thing can be done almost as if by magic. If you have five windows, the five boys who sit nearest to them, automatically take them as their jobs. The same way with each blackboard slate, the wastebasket, the bookcase, the reading table, the crayon box, the dictionary stand, the front seats. Each student is, of course, also responsible for the condition of his own desk. When the teacher says, "Police quarters" the work should be done in a half minute. After a little, no directions will be necessary; the service has become automatic. Repairs should be called to the attention of the boy Student Council member, whose business it is to see that they are reported. There is no valid reason why your boy Student Council member should not take charge of "policing quarters" if you prefer to have the students handle it.

In addition, the efficient teacher "sets up lab" before going home each night. She gets ready for tomorrow's work today. Before leaving she lays out the material listed on her new lesson plans, sees that the supply of crayon and erasers is adequate, and that ink wells are filled. The teacher who complains during a class period that the ink wells are not filled, criticises herself instead of the janitor. The fact that she did not check this the preceding night is a plain token of fuzzy planning, or of lazy and inefficient organization.

The beginning teacher will do well to guard against wordiness in this branch of her work. "Ready for roll!" should mean that monitors stand instantly, examine their lines, and either say "All present," or name the absentee as the teacher makes the office record. "Next!" means next monitor reports. "Permits!" means everyone absent yesterday reports with his slip to the front. Not a movement of any kind should interrupt until the monitor leaves with his report. It won't, if children are made to understand that we lose money if they are reported absent when they are not. "Papers!" is a much more effective command than

"Everyone get ready to hand in his work. Jack, you collect those two lines and June, you can get these."

"Papers" should mean that each paper is in a definitely agreed upon place *instantly, no matter whether they are completed or not.* If it doesn't mean this, both class and teacher are wasting time. It should also mean that the unprepared or absent student turns in an entire sheet with his explanation at the top. This can be returned with his make-up assignment listed after you have noted it in your *individual instruction* note book. "Time!" to a class at the board means: "Your time is now up. Stop where you are." It is a vastly more businesslike statement of what is wanted than the longer phrase. Can't you imagine how tired the children in her class could get of listening to such a long-winded individual until four o'clock. But many children have to!

The use of the blackboard is greatly facilitated if the instructor the first day he meets the class will divide that class into sections, route each section to boards separately, taking pains to see that no students have to pass in the aisles, and explain that always during the coming semester they are to stand in front of the same slate. "Stand in front of the eraser" saves confusion the first day in elementary classes if the teacher "sets up lab" the night before. The teacher who puts on her front board daily during the first week, "Please sharpen your pencils and get any missing material between bells.—No permission afterward," and who stands in her door between the room and the corridor to say "Quietly, please," to the entrant who seems to need it, will have insured herself against much trouble a term later. That list later may be changed to "Please get drinks," or "Please go to the lower floor if necessary" or to any other phrase which covers a preventable undesirable situation.

"Gentlemen never use toothpicks in public" or "Gum chewing should be done in one's own room" are just as effective from the board as at the end of an oral lecture. "Please pass quietly" from the board should be tried by the teacher who is inclined to lecture too long. There is not the personal element apt to produce the reaction of anger that may accompany an oral command, especially if it is given with an edge on the voice; but the teacher giving this kind of direction *should never mention it.* It is there for the express purpose of preventing the necessity of mentioning it. If you think this is not an important factor, list the last ten cases of rebuke you have had to administer and see in how many of them you can honestly say "I did not talk too much."

The second big point which needs emphasis for the young teacher is this: While establishing such routines, begin as you expect to go on, and *never allow any deviation unless it has been formally discussed and adopted as a permanent policy.* When such a change is made, drill on it long enough to establish the new habit. "She let us once" is a fruitful source of trouble when one is trying to establish a habit. Methods of taking roll, recording absences, verifying permits, passing into room, passing out of room, passing to and from blackboard stations, collecting and distributing books, or material heading written lessons, checking spelling or arithmetic lessons and all kinds of fact tests, passing in and out of chapel, dismissals at noon or night, routing traffic lines in corridors, securing wraps from lockers,—all these are matters that should be mechanized immediately, and the established method never deviated from.

If you believe you have a better method to suggest than the one in use, bring it up in faculty meeting for discussion. If your method is not adopted, you should continue to use the prescribed one, because the good of the entire school comes before that of any individual room or teacher, and the prescribed routine has evidently been laid out with the best interests of the larger number in view. Often we find teachers so interested in their own work that they neglect to carry out instructions from the office. That interest in work is commendable from one angle, *but not when it interferes with the orderly routine of an entire school.* An order from the office or a request from the supervisor should be attended to before anything else, as it may upset the office working force at a waste of both time and money. If we have office employees paid by the hour, a tardy monthly report, a missing report card that you should have looked up weeks previously, an unalphabetized posting list, runs into money, as well as into time and temper. A "tickler" or memorandum book or calendar listing the things you are to do today, tomorrow, and the 15th of next month will save many irate feelings. When you tell John Jones to report at 8:30 Tuesday with ten sentences, that note should go into Tuesday's tickler at that moment, and John should know it.

Probably the two most glaring errors of the inexperienced young teacher and the weak older one as well are: (1) She is not efficiently systematic; (2) *In matters of school management* she talks too much.

The slogan of salvation for the beginning teacher is: "Plan your work and then work your plan." The prescription is—Organize; Systematize; Automatize! But she never can for an instant forget that the prescription applies to matters of daily routine only, to matters of housekeeping and management, *never to her teaching.* ●

CHRISTMAS SEALS

Protect Your Home from Tuberculosis

Enriched Bread

● By Charles Hoffman, Ph.D.
RESEARCH DIRECTOR, WARD BAKING COMPANY, NEW YORK CITY.

A very modern development in foods is Enriched Bread.

What is it? Is it new? Is it expensive? What enriches it? Why are the enriching materials needed? Why is it better than ordinary bread? Has it Government approval? Will it supply the minerals and vitamins that are not provided by many daily foods?

Here are the answers.

●

Less than a year ago, enriched bread was introduced to the American public. And today, it is recognized as one of the greatest contributions to public nutrition that has been made in a half century.

Men in the Army and Navy eat enriched white bread, and the Government recommends enriched bread to every civilian as an important aid to better health. In fact, a leading government nutrition expert asks that we "do not accept any white bread . . . that does not have the word 'enriched' on the label."

What is this new bread that has attracted so much attention, that is hailed as a modern miracle? Enriched bread is a white bread. It looks and tastes just like every-day white bread. But there are extra vitamins and minerals in enriched bread which are not found in former white bread. The presence of these health elements sets enriched bread apart from ordinary white bread.

White bread may be enriched in several ways: by the use of enriched yeast or flour; by the use of vitamins and minerals in powder form; or by a combination of these methods. Thus, the baker can restore the valuable health elements which are lost in the milling of white flour and which fortify white bread nutritionally.

Enriched bread contains extra vitamin B_1, the pep vitamin; niacin, an important element in the vitamin B complex; and food iron. Vitamin B_1 helps build calm nerves, good digestion and high morale. Food iron helps keep you feeling tip-top, ready for a day's work.

Enriched bread costs the consumer no more than ordinary white bread, but it is important to remember that not all white breads are enriched. The housewife can identify enriched bread by its wrapper, which has the word "enriched" printed on it.

One of the pioneers in the enriched bread field is the Ward Baking Company. Shortly after May, 1941, when the government launched its enriched bread campaign, Ward began enriching Tip-Top Bread.

However, for a quarter of a century Ward has been studying the vital importance of bread as a factor in building a strong America. Back in 1914, under my direction, a research and control laboratory was established by the Ward Company at the Bronx Plant, and here was developed the first vitamin-enriched bread to go on the market. This bread made its appearance in 1923 under the name of Vitovim Bread.

Today, Ward again has assumed leadership in the baking industry for enriched white bread. We were among the first of the major baking companies in the nation to cooperate wholeheartedly with the government on its enriched white bread campaign. Our promotion of enriched bread has been uninterrupted. Now it is estimated that more than two-thirds of all bakers' white bread is enriched.

According to government nutrition experts, three-fourths of the American people are inadequately fed,—hungry for the vitamins and minerals that many daily foods do not provide. Enriched white bread, one of our most important daily foods, is helping to correct this situation. Six slices, approximately 6 ounces, of enriched bread eaten each day will supply at least one-third of the estimated daily requirements of vitamin B_1, niacin and iron. Enriched white bread is playing a vital role in building better national health at a time when America needs strong healthy citizens to win the War.

White bread, when enriched, becomes one of the preferred foods as a source of vitamins and minerals. It is important to remember, too, that when it is consumed as bread the full quota of vitamins is present since there are no losses in preparation. Many foods enriched in vitamins lose a large portion of these essential elements during the preparation, from cooking and other losses.

It is well to bear in mind that mild toasting does not destroy much of the vitamin content. However, heavy toasting should be avoided. The vitamin content of products such as Melba toast is reduced from 30 to 50 per cent of the original product from which it is made.

Enriched bread, truly, is one of the cheapest and best foods you can buy, and because of its vitamins and minerals should have a prominent place at every meal. ●

Fiberglas

A New Basic Material

● **By William H. Page**
BUREAU OF INDUSTRIAL SERVICE, NEW YORK CITY.

Here is an amazing story of the discovery and development of a new basic industrial material that as recently as five years ago was still unknown to the public.

Now it is an efficient and widely used heat insulator. It is employed in the making of yarns and decorative fabrics. It is a valuable electrical insulator. It finds uses even in surgery.

This article will bring up-to-date your information concerning recent developments in one phase of the glass industry.

●

During the past decade, Fiberglas, glass in soft, flexible, fiber form, has achieved recognition as a new, basic industrial material.

The word *basic* is the keynote here. It means that Fiberglas, like steel, or aluminum or petroleum, is a product that industry employs in scores of different ways, for scores of different purposes, to produce scores of different products.

That glass can be made in a form which can be bent like rubber, tied in a knot like string, and woven on a loom like cotton, silk or wool, seems, and is, a remarkable achievement.

It is as if we were suddenly able to breed pigs that sing and cows that roost in trees, so different are the characteristics of Fiberglas from those of glass in its traditional hard, unbendable form.

The physical characteristics of Fiberglas which everyone can feel or see are, however, far from being the whole story. With them are combined other characteristics which are equally important in giving Fiberglas its position as a basic material. For instance:

Fiberglas fibers possess a tensile strength greater than that of the finest steel wire of the same diameter.

The diameter of the fibers can be exactly predetermined and controlled; they will not stretch or shrink; they will not absorb moisture; they will not rot or mildew; they are chemically stable and are not attacked by corrosion.

The fibers will not burn; they are resistant to the effects of high temperatures; they possess high dielectric strength and insulation resistance when suitably impregnated or varnished.

Except to the technically trained man and to him only if he possesses imagination, the bare list of the characteristics of Fiberglas can convey no clear picture of the immensely wide field of usefulness open to the material that possesses them. They are, however, the very foundation of the service Fiberglas is able to perform.

A Long Quest

Men have tried for centuries to make glass flexible. A Roman is said to have learned how to make a malleable glass, only to have his head chopped off by the emperor so that the discovery would not lessen the value of gold and silver.

The Venetians learned how to draw glass into hair-like strands which they used as decoration for their glassware. Patents on the formation of strands of glass fibers were among the first to be granted by the United States Patent Office.

Glass marbles to be used in the manufacture of Fiberglas textiles. From one marble 97 miles of glass filament can be drawn.

By 1893, Edward D. Libbey, of the Libbey Glass Company, was able to draw thin strands of glass from a heated rod rotated by a foot pedal. The strands were woven together

with silk and made into lampshades which were shown at the Columbian Exposition in Chicago.

There a celebrated actress saw the shades and arranged to have a dress made of the same fabric. So fascinating was the idea of a glass dress that Princess Eulalie of Spain determined that she, too, must have one. For her glass dress, the princess is said to have paid $30,000.

In the production of Fiberglas thermal insulation, the molten glass pours in streams, smaller than a pencil lead, into roaring jets of high-pressure steam, travelling at the speed of a rifle bullet. The steam literally yanks the glass apart into long, fine fibers which are driven downward onto a travelling conveyor. From a forming chamber a light, fleece-like mass of intricately interlaced fibers emerges in an endless stream.

The only trouble was, none of these strands of glass was really flexible. This, however, was about the limit of progress up to 1931 when the Owens-Illinois Glass Company established a separate division to conduct research on glass.

In attempting to fuse colored glass to the sides of milk bottles, the Owens-Illinois research workers melted finely powdered colored glass with a blow torch and simultaneously forced it against the bottle.

The glass failed to adhere to the bottle. Instead it was blown into fine filaments which piled up in a fluffy mass.

The research workers had not been thinking about flexible glass, but they realized that they had stumbled upon something important. They had, in fact, stumbled upon the basis of the first practical method of making a truly flexible glass.

Throughout the early 1930's both Owens-Illinois and Corning Glass Works actively engaged in research and development work aimed at producing glass in flexible, fiber form and in finding where and how it might be usefully employed.

Because of the similarity of their aims, the two companies agreed to cooperate in research and development work in this field. Rapid progress was made.

Then, in 1938, Owens-Illinois Fiberglas Corporation was formed to manufacture glass fiber—or Fiberglas—materials, and to continue the research and development work pioneered by Owens-Illinois Glass Company and Corning Glass Works.

Manufacturing Processes

Today the manufacture of Fiberglas is a highly technical, specialized process, or rather group of processes. The first step is the selection, mixing, and melting of the raw materials, silicates and mineral oxides.

Ordinary window glass is of the soda-lime type, made by the fusion of sand, limestone and sodium carbonate. A pound of window glass has a surface area of about 1.3 square feet, but if drawn into fiber form its surface area would be increased some ten thousand times.

For this reason, and for many others, it is necessary to develop special glass formulae to provide the almost incredibly fine glass fibers with resistance to weathering, chemical action and other influences to which they will be exposed.

By the substitution or addition of various mineral oxides, by varying the proportions of the ingredients, by close temperature control, and, finally, by controlling the diameter of the fibers, the fibers are given the special qualities they must possess to enable them to perform the service for which they are designed.

Two basic types of glass fibers are produced:

Fibers which are interlaced in a fluffy, wool-like mass for fabrication into bats, blankets, rigid and semi-rigid sheets, and other forms.

Fibers which are twisted and plied into yarns which, in turn, are woven into braids, tapes and cloths.

In producing the first type of fibers, the molten glass is caught by jets of steam as it flows out of small holes in the furnace. The steam hits the glass with terrific force, and literally yanks it into thread-like fibers. The fibers fall upon a moving conveyor belt by which they are carried to the point of fabrication.

In the manufacture of the textile fibers two processes are employed, the continuous process and the staple process. Both processes require that the melted glass batch be moulded into marbles which are carefully inspected for defects or impurities that might affect the tensile strength or other qualities of the fibers. Then the marbles are re-melted in small electric furnaces with many small holes in their base through which the molten glass flows.

In the continuous process, 200 filaments or more are drawn simultaneously from the molten glass in the furnace, are gathered together into a strand, and are caught on a winder that revolves at high speed. These filaments, each 15 times finer than a human hair, have a tensile strength of over 400,000 pounds per square inch, greater than that of hard-drawn steel wire.

In the staple process, high pressure jets of steam or air tear the streams of molten glass apart as they pour from the furnace, and draw the particles into long, smooth fibers varying in length from 8 to 15 inches—much greater than the length of the best long-staple cotton.

Both the continuous and staple fibers are twisted and plied on standard textile machinery into yarns from which braids, tapes and cloths are woven. The continuous fibers can be woven into smoother, harder-finished fabrics than can the staple fibers, but fabrics made from the staple fibers have greater bulk.

Fiberglas Thermal Insulation

When glass fibers are interlaced to form a soft, wool-like mass, or when the fibers are treated with a binder and compressed to form rigid or semi-rigid sheets, millions of air cells are entrapped. These cells retard the flow of heat.

Fiberglas thermal insulation is used to insulate shipboard refrigerated spaces, living spaces, magazines, bulkheads, piping, ventilating ducts, casings and boiler uptakes.

Where the fine, cylindrical fibers cross and touch each other they have exceedingly small contact points. Heat, therefore, cannot pass easily from one fiber to another.

Add to this the fact that the fibers will not burn, rot or mildew . . . that they will not settle under vibration . . . that individually and in the mass they are extremely light in weight . . . and you have the chief reasons why Fiberglas is one of the most efficient and widely used heat insulating materials.

The ships of the United States Navy cruise from the tropics to the Arctic and Antarctic Circles. The sun of the Equator shining on a steel plate may raise its temperature well above 125° Fahrenheit. Heat insulation of living spaces is essential to make life endurable.

Furthermore, the ship must carry food for a large number of men for a long period of time. The seaman of today eats fresh meat, dairy products and fresh vegetables, in place of the salt pork and hardtack that was his fare prior to the advent of refrigeration. The preservation of such foodstuffs requires the use of large amounts of heat insulation.

In 1932, shortly after the first Fiberglas heat insulation material was produced, it was installed in several Navy ships on horizontal surfaces. The insulation performed so efficiently that it was adopted for all horizontal surfaces in living spaces and magazines, and for all spaces in refrigerators, in all fighting craft designed after 1935. In 1939, the Navy adopted glass fiber material as heat insulation throughout all its fighting ships.

In the meantime, use of Fiberglas insulation spread to merchant ships built by the Maritime Commission. In 1942, more than 75 shipyards engaged in building Naval or merchant vessels, or both, are using Fiberglas heat insulation in its various forms to insulate living spaces, refrigerated spaces, magazines, bulkheads, pipes, ventilating ducts, casings and boiler uptakes.

On shore, as well as at sea, Fiberglas thermal insulation helps control the flow of heat and cold. It is used to insulate dwellings, industrial buildings and other structures where it is proving highly efficient in keeping heat inside in winter and outside in summer.

Fiberglas is used for the thermal insulation of trains and airplanes. Manufacturers of refrigerators, ranges and heating units have found that their products work more efficiently and have a longer useful life when insulated with Fiberglas. Fiberglas pipe covering is widely used for insulating steam, and hot and cold water piping in industrial plants and on shipboard.

Early in 1942 a new type of Fiberglas board, composed of compressed glass fibers sheathed with an asphalt coating, was developed for use as cold storage insulation. Coming off the production line at a time when Axis submarines were seriously curtailing our imports of cork, the new board has relieved us from our dependence upon cork for the insulation of the cold storage installations required to preserve our perishable foods.

Fiberglas Textiles

Prior to Pearl Harbor, Fiberglas fibers, twisted and plied into yarns, were used for weaving a wide variety of decorative fabrics. Damasks, brocades, satins, taffetas and nets woven of the yarns were used in the form of draperies, glass curtains, shower curtains, bedspreads, table cloths and lamp shades. Glass fibers were combined with silk and rayon in the production of fabrics used for neckties.

(Continued on Page One Hundred and Twenty-four)

The Rating of Examination Papers in Science

● **Material Supplied by Dr. Ellis L. Manning**
SUPERVISOR OF SCIENCE, STATE EDUCATION DEPARTMENT, ALBANY, N. Y.

Many instructors who can prepare a good examination are unable to rate the answer papers fairly and with a reasonable degree of uniformity. They have not been taught!

Such a situation cannot be permitted to exist, especially in the case of state-wide examinations such as the nationally known Regents examinations of New York State. A guide for examiners has been prepared by the State Education Department with the help of a number of science teachers who have served as junior education examiners at Albany. The suggestions given here are taken from the guide by permission of Dr. Manning.

The Editor doubts if there is any teacher of science anywhere who cannot derive something of benefit from this article.

●

Most teachers agree that good rating practice is merely that practice which should apply, continuously, to the evaluation of pupils' work throughout the school year.

Actually, successful teachers feel that classroom standards of accomplishment may well exceed the standard proposed as acceptable for Regents examinations. They suggest that pupils' habits of work are conditioned, favorably or otherwise, by the day-by-day classroom standard of accomplishment. They feel that teachers who adopt classroom standards higher than those presented here realize important outcomes of science teaching—neatness, clarity of expression, accuracy of computation and completeness of explanation.

Obviously, the pupil who receives classroom credit for work half done, or poorly described, or incorrectly calculated, soon learns to expect credit for work of that character. Just as obviously, he will attempt to correct poor classroom work whenever it is apparent that only good work is adequately rewarded.

General Suggestions

No set of directions can discuss every situation that may arise. General suggestions apply to the answer papers in all the science fields. Each of the four fields may present special rating problems. An attempt is made here to discuss some of these problems and to present examples of good rating practice as it applies to these special cases. **Good rating practice is that which assigns full credit to every correct, responsive answer, and which assigns partial credit—never less than one unit of credit when such partial credit is justified—uniformly and equally, to answers that fail to merit full credit. Careful analyses of the questions themselves and the exercise of common sense and good judgment are important rating technics.**

In order to insure reasonable uniformity, locally, in the assignment of credit, it is suggested that the teacher prepare and use an answer "key." As pupils' answers are read, additions to the initial list of keyed answers may be needed. At the end of the rating, the key should contain all the accepted answers and the amounts of credit assigned to these answers; equable and uniform assignment of credit is facilitated by this procedure.

When rating papers, show *errors* and *omissions* in part I by a check, with *red pencil*, at the right of the incorrect or omitted answer. Part I questions are objective; the answers to these questions are right or wrong. Do not assign *fractional units* of credit to them.

Some pupils fail to follow the directions that accompany the modified true-false type of question in part I. In this type of question the directions tell the pupil that there are true and false statements in the group; that he is to mark all true statements *true;* that he is to *correct* all false statements by *substituting a proper term* for the italicized incorrect term. *No credit* whatsoever may be allowed for answers that do not comply exactly with the directions for such questions. This type of question and the directions accompanying it might well be used in class to accustom pupils to it.

Record, with red pencil, the total credit allowed for part I at the end of part I and again at the beginning of part II. *Do not mark acceptable answers.*

Underline with red pencil *errors* in answers to part II and part III questions and indicate each *omission* by a caret mark ($_\wedge$) in red. Show errors in diagrams and mathematics by red circles. Do not mark acceptable answers. Opposite each part of the question record the credit *allowed*, and after each question record in the right-hand margin the cumulative total. In short, the reviewed paper will show, plainly, *all incorrect* and *omitted answers; no other marks*, except the numerical credit assignments, should be made on the answer papers. Place credit claimed for the paper in the upper right-hand *corner* of the outside page, with *red pencil.*

Assign credits impartially to the answers to part II and to part III questions. Do not attempt to "interpret" pupil answers.

Specific Suggestions

The questions that appear in part II and in part III may involve diagrams, descriptions of experiments, explanations, equations and mathematical problems. The following discussion will suggest the proper rating procedures to be used in evaluating such answers.

Diagrams. In some questions or part questions, diagrams constitute the principal part of the answer. Question committees are making every effort to word such questions so that the credit distribution is clearly indicated. Proper partial credit assignment may then be shown by the wording of the question. Some pertinent suggestions follow:

1 "Make a labeled diagram that shows the laboratory preparation and collection of hydrogen chloride. (3)" One credit is assigned to the method of collection, one credit is assigned for the type of reaction and one credit is assigned to the diagram and labels. In order that an answer may receive full credit the method of collection must be correct, a source of heat must be shown if heat is required for the preparation and the apparatus must be of a practical and usable nature.

2 "Make a diagram that shows the probable structure of the fluorine atom. (2)" One credit is assigned to a correctly drawn and labeled nucleus, including the proper number of neutrons and protons, and one credit is given for the correct number and arrangement of electrons around the nucleus.

3 "Make a labeled diagram of three structures found in almost all cells. (3)" One credit is allowed for each of the three correctly drawn and labeled parts of the cell.

4 "Make a labeled diagram that shows the prevailing westerly, the trade-wind and the calm belts, at the time of the equinox. The diagram should include both northern and southern hemispheres. (4)" Assign one credit to the correct location and name of each of the following: the doldrum belt, the horse latitude belts, the prevailing westerly belts and the trade-wind belts.

5 "Diagram a ray of light entering a glass block at an angle; label the normal, the refracted ray and the angle of incidence. (3)" One credit is given to each item when each is correctly drawn and labeled.

All such questions require careful study by the rater, in order that acceptable credit distribution may be made.

Teachers may wish to establish higher standards for the rating of periodic school examinations. In such examinations, award of partial credit may well be eliminated. Pupils learn to make correct diagrams when partially incorrect diagrams earn *no* credit. Moreover, periodic school examinations serve a double purpose: they are used to evaluate pupil work, and to indicate areas of pupil weakness. Since the minimum passing score on these examinations is not fixed, high rating standards may be applied as teaching devices, without undue penalty.

Experiments and Demonstrations. The rater should exercise good judgment when evaluating answers to this type of question. Generally, half credit is assigned to subject matter and half to technic. Subject matter includes the facts, observations and conclusion of the experiment; while technic includes apparatus manipulation, reasonable controls and the variation of one experimental factor at a time. Credit is given to each part only when all of these ideas are correctly stated.

A pupil's actual answer to question 7 of the June 1941 biology paper illustrates a response that is entitled to full credit. The question reads:

> "Choose a laboratory exercise or experiment performed when you studied one of these topics: tropisms, protozoa, genetics.
>
> *a* State the facts or the information obtained from the experiment. (4)
>
> *b* State the conclusion drawn from these facts. (2)
>
> *c* Did this experiment justify the conclusion? (1)
>
> *d* Give definite reasons for your answer to *c*. (3)"

The answer reads:

> "*a* Seeds were placed on a damp blotter between glass plates. The plates were placed upright. When the seeds sprouted the roots grew downward. Then the position of the plates was changed to a horizontal position. The roots changed their course and started to grown downward from the new angle. Again the plates were moved. They were placed upside down, and the roots, following the pull of gravity, grew in the opposite direction from which they first grew.
>
> "*b* This experiment proves that plants respond to gravity.
>
> "*c* The experiment did justify the conclusion.
>
> "*d* This experiment showed how the roots of a plant reacted when the plants were moved from one position to others. It was done to learn how plants respond to gravity and it succeeded in demonstrating that the roots changed their course as a result of geotropism."

Explanations. Questions of this type cause a wide variety of pupil responses and therefore great care and good judgment are needed to rate the answers. Usually, the question paper assigns two credits to each explanation. One credit is assigned to the principle and one to the explanation based on the principle. The principle should be clearly and accurately stated or *implied*. The explanation on the basis of the principle should show real understanding and not mere memorization of words.

Equations. Many questions that call for balanced equations are allocated two credits. Full credit should be assigned only when the equation is wholly correct. One of the two credits may be assigned when *all* formulae are correct, although molecular coefficients are not properly balanced. No credit should be assigned to equations that contain an incorrect formula. Assign no *fractional* units of credit.

(Continued on Page One Hundred and Twenty-nine)

Frequency Modulation

● **By Dwight A. Myer**
CHIEF ENGINEER, RADIO STATION KDKA, PITTSBURGH, PA.

This interesting paper offers our readers an opportunity to learn about FM broadcasting from an expert in the field.

FM has received such complimentary advance notices that a very considerable public interest has been aroused. Soon there will be demands upon the teacher to explain its operation and to show how it differs from broadcasting of the ordinary type.

Here is an authoritative answer to many questions that may be asked.

●

Had it not been for the war, the new system of frequency modulation broadcasting would perhaps have continued to spread throughout the country with an even greater increase in its popularity. Now with the existing scarcity of raw materials, all broadcast expansion has been frozen and broadcast receiver manufacture discontinued. This drastic curtailment has stopped the progress of frequency modulation, as far as the public is concerned, and we must await the coming of peace before many of us can become acquainted with this new system.

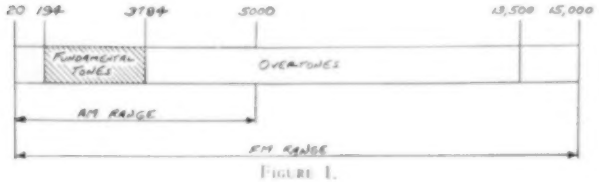


FIGURE 1.

Undoubtedly, further development of this new scheme is continuing behind the locked doors of our large manufacturing plants. As occurred in the last war, from out of the laboratories and research departments of these companies will come many unfoldments and advancements, which will result in the industry being placed ahead in a yearly ratio of about four to one of normal peace time growth. While it is a pleasant sensation to allow our fancies to wander and attempt to imagine what some of these evolvements might be, it is perhaps more in keeping with the times to examine the known facts. With this in mind, we will briefly look into frequency modulation and compare it with the older form of broadcasting known as amplitude modulation.

Frequency modulation (FM) has received considerable advertisement, all of it of the favorable kind;

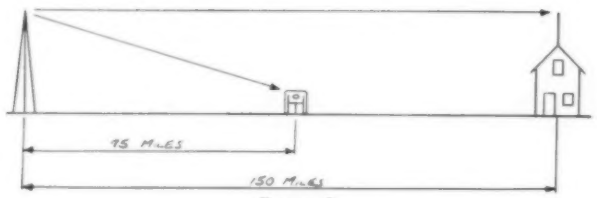


FIGURE 2.

therefore it is reputed to be much better than the older and more familiar form of standard broadcasting. FM, or frequency modulation, is different from AM, or amplitude modulation, and it is true it has certain definite advantages over the old type (AM) broadcasting. On the other hand, FM has certain limitations, or perhaps disadvantages, compared to AM broadcasting. We should certainly hesitate to say FM will eventually entirely replace AM broadcasting.

Unfortunately, it is difficult to explain the working of FM and to make a comparison with the older system. Analogies do not lend themselves well to the explanation. It should be explained first that both systems employ a carrier wave, over which programs "ride" to the listeners' receiving sets. This carrier might perhaps be compared to a beam of light.

The fundamental difference between the two systems is that in amplitude modulation the carrier frequency remains constant and the power put into the carrier is varied or modulated; while in frequency modulation the power put into the carrier remains constant, but the carrier frequency varies around a fixed frequency. To carry the analogy a bit farther we might say that in AM the beam of light varies in intensity, while in FM the intensity remains constant but the light varies in color.

In other words, in AM broadcasting the carrier continuously vibrates at the assigned carrier frequency of the transmitter. For example, let us take an AM

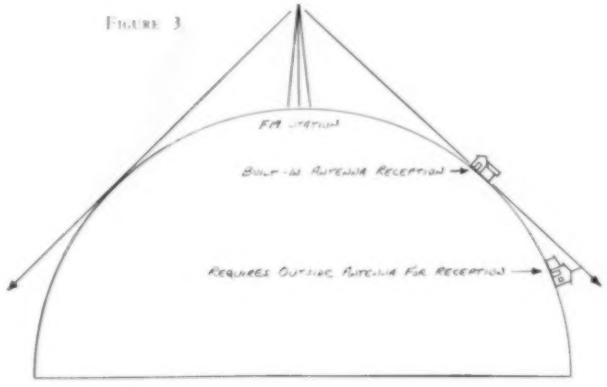


FIGURE 3

transmitter with an assigned frequency of 1000 KC (1,000,000 cycles per second). In order to produce a response in the receiver, the power contained in this carrier is varied or modulated in accordance with the individual tones of a musical instrument or a speaker's voice. The louder the tone, the more the power is varied.

In FM there is constant power in the carrier, but this power is distributed at a different rate. The intensity, loudness or softness, of the musical note will vary the extent of the carrier modulation, while the pitch or tone will vary the rate (or frequency) of the carrier itself.

Now, of course, both of these carriers travel through the medium known as the ether. Although not too much is known about the ether, a few things are known, and one of these is the speed at which ether waves travel. This speed is 186,000 miles per second, or approximately 300,000,000 meters per second.

With this speed of 300,000,000 meters per second, if we vary an impulse to the ether 200,000 times per second, we will have a distance (or wave length) between impulses of 1,500 meters. Again, if the impulses are varied 500,000 times per second, we have a wave length of 600 meters. Standard, or amplitude modulated broadcast transmitters have a wave length lying somewhere between 200 meters and 540 meters. This is 1,500,000 to 550,000 cycles, or 1,500 to 550 kilocycles. The frequencies in this band are known as the standard frequencies.

Frequencies above 1,500 kilocycles are known as high frequencies. Those still higher, say above 30 megacycles (30,000,000 cycles) are known as the ultra-high frequencies.

FM broadcasting takes place in the ultra-high frequencies, while AM broadcasting takes place in the lower or standard frequencies. The AM broadcasting stations use a carrier channel width of 10,000 cycles, or 10 KC. This width is all that has been allowed by the Federal Communications Commission, and means there can be a frequency swing of 5,000 cycles, plus or minus, either side of the carrier, making a total swing of 10,000 cycles. This side-band swing tolerance could not have been made much larger as there would not have been enough room in the band to allow all the some 875 broadcast stations in the country to operate. Even as conditions are, there are many stations operating simultaneously with other stations on the same frequency, there being only some twenty-five stations throughout the nation enjoying operation on a frequency assigned to them only. These twenty-five stations are known as clear-channel stations, and it is through these stations rural districts obtain their radio reception.

As mentioned above, it has been shown that AM stations are only allowed 5,000 cycles above and below a station's carrier frequency, and it can be shown that a limit of 5,000 cycles is not nearly adequate to broadcast properly true fidelity, or even high quality music, as over-tones of certain instruments may go as high as 12,000 or even 15,000 cycles. To make high quality transmission possible on the new system of carrier frequency shifting rather than carrier power variation, FM has to operate at the very high or ultra-high frequencies, where enough room in the frequency spectrum could be found. Actually, FM transmitters might use a carrier frequency shift of 100,000 cycles above and below its mean operating point; and, in fact, the Federal Communications Commission has allowed FM channel widths of 200,000 cycles. It can be seen from the above why it has been necessary to allocate FM transmissions to the ultra-high frequencies. (Fig. 1.)

Another point which is known about the ether is its somewhat peculiar behavior as far as some frequencies are concerned. Over a period of years, and by means of many experiments it has been found that frequencies lower than approximately 35 megacycles will bend back to earth. They seem to be reflected back at varied distances depending upon the frequencies and time of day. By this bending process they sometimes are able to follow around the earth's surface and cover great distances. Also this same characteristic will cause fading and interference with distant transmissions. On the other hand, frequencies above 35 megacycles are not reflected back to earth, but are lost in the great void surrounding it. Radiations in this part of the spectrum take on the characteristics of light waves. They travel in a straight line, and are usually stopped when they hit some obstruction such as a mountain or large building. They have no bending properties to speak of, and in general follow the "line of sight" principle, making it possible to transmit only about twice the distance of the antenna to the horizon. True, the higher the antenna the farther they will transmit, but, after all, there is a physical limit to the height to which any antenna can be erected.

It should be pointed out that radiations occurring in the standard frequencies have what is referred to as a ground wave and a sky wave. The ground wave continues outward in an ever widening circle until it is finally weakened and absorbed by the losses occurring in the ground over which it travels. The sky wave goes out at all angles and is therefore reflected back to the earth at different distances, depending upon the angle of incidence at which it strikes the Heaviside layer. As the frequency of transmission rises, the ground wave becomes more and more useless and valueless as a transmission factor until, by the time the frequencies in the ultra-high range are reached, the ground has disappeared. Therefore, FM in the ultra-high range uses sky wave transmission.

FM Advantages

It is apparent then, that the FM system as compared to the AM system has several differences, resulting in various advantages and disadvantages. Before going further, a comparison will be made between the two systems.

Advantages of FM over AM broadcasting:

1. No fading due to reflected waves such as occur in the standard or amplitude method of broadcasting.

2. Due to its limited "line of sight" transmission, many more stations can be accommodated in the country than with the amplitude system of broadcasting.

3. By reason of the wider channels higher fidelity in its broadcasts may be obtained.

4. Due to inherent technical advantages in the FM circuits, transmissions may be obtained with less distortion.

5. Due to a characteristic of the FM circuit action in the FM receivers, an FM receiver will not respond to two FM signals at the same time. The receiver will pick out the strongest signal automatically and listen to it only.

6. FM circuit action discriminates against miscellaneous noise.

FM has the following Disadvantages:

1. FM, due to its "line of sight" characteristic, has a very limited range making it entirely worthless for national radio coverage such as is obtained today with the standard broadcast system. No rural coverage is possible. No long distance broadcast records can be run up by the listeners.

2. At present, there is an economical disadvantage inasmuch as a good FM receiver is considerably more expensive than the standard broadcast receiver.

3. In most cases, and actually in all cases, for good reception a special antenna should be erected which is somewhat expensive and difficult to erect. (Fig. 3.)

4. Even for local FM stations, not all receiving sites are suitable for FM reception.

5. Automobile, neon sign and diathermy machinery noises are more pronounced on the ultra-high frequencies than on the standard frequencies.

Why No Interference

As stated above, FM will afford reception free from interference by another FM station. Since these stations do not transmit for great distances, there is no danger of sky wave or skip distance interference to be experienced as is the case with the standard broadcast stations. There will be no unwanted intrusion from another station a thousand miles away, and no searching for a station that could be heard last night but cannot be heard tonight. You can either hear an FM station or you can't hear it. Seasons of the year and time of day have little effect on the ultra-high frequencies. (Note:—The foregoing does not hold true during extremely rare occasions of short duration during sun-spot activity.)

There is sufficient room in the high frequency band to grant licenses to many more FM stations without the slightest danger of interference. Remember, an FM station will transmit a distance of only about twice the distance of the horizon, and further, the Federal Communications Commission has specified that stations serving the same area shall not operate on adjacent channels. With these precautions, high powered FM stations operating only a hundred miles or so apart can operate freely without interfering with one another.

There is a characteristic inherent in FM which prevents one wave from interfering with another, even though they are on the same band, unless the two have almost equal signal strength. The FM receiver will automatically select the stronger signal and stay with it. The weaker signal is completely blanked out and there is no double reception or "monkey chatter" heard in the receiver, as frequently occurs in AM reception. The characteristic has been checked by engineers using an FM receiver located in an auto and driven to a point apparently midway between two FM stations transmitting on the same frequency. The balance is so delicate that moving the car just a few feet will completely blank out one station in favor of the other, while moving it back will immediately blank out the second station and bring in the first one perfectly. (Fig. 4.)

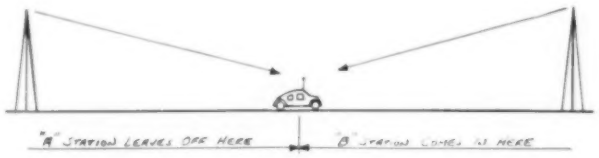


FIGURE 4.

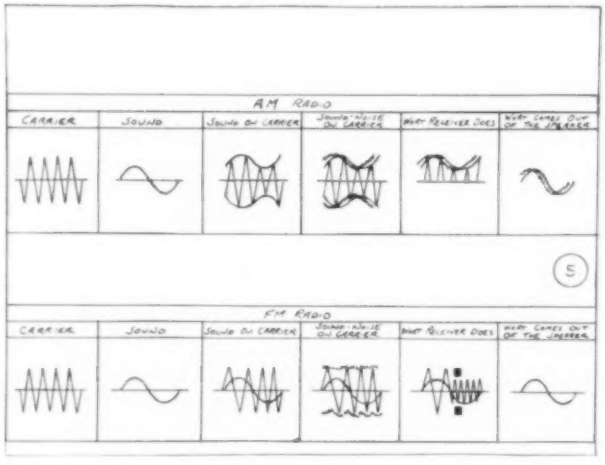
Why FM is Unusually Free of Interference

Noise-free reception is a property of correctly designed and operated FM receivers. Various noises arising from man-made and natural sources sometimes travel a long way. These interfering noise waves are, for the most part, amplitude modulated, that is, they vary in strength or intensity. Even more important, these unwanted radio waves act as carriers of other noises. Another characteristic which increases the bad features of noise signals is the fact that they appear not on a single spot on the radio dial, but instead cover wide bands of the spectrum. Thus noise sometimes ruins reception of many of the stations at the same time.

Because the noise signals cover wide swaths in the radio band, a receiver, FM or AM, which is tuned to

(Continued on Page One Hundred and Twenty-six)

FIGURE 5.



Weeds as Medicines

● **By Elbert Voss, Ph.D.,** *(University of Florida)*
PROFESSOR OF PHARMACOGNOSY, DUQUESNE UNIVERSITY, PITTSBURGH, PA.

Many of our familiar garden plants and common weeds have long been used as medicines. Everyone is familiar with catnep and dandelion, and most persons know jimson weed under one of its several names. Not many laymen know the medicinal uses of these common plants.

Here Dr. Voss discusses these drugs briefly and in a "popular" manner.

●

At one time or another practically every plant in the garden or field or forest has been used in man's attempts to lessen pain and relieve suffering. Both the common and the scientific names now applied to a great number of plants remind us of their present or former uses as medicines. Many familiar wild plants have long and interesting histories of service in the alleviation of the ills of mankind.

Botany and medicine came down through the centuries hand in hand until the Seventeenth Century. Then, as both became more scientific, their ways parted. This separation brought to an end the need for the old herbals, books designed for the layman as well as for the physician, dealing with plant lore, the medicinal uses of the herbs, and their botanical classification. It is customary for modern botanists to ignore completely the medicinal properties of the plants they study.

The old-time herbalist was both physician and botanist. He knew many plants by their vernacular names, and he knew when to collect, how to cure, and how to make from them preparations suitable for the treatment of various ailments. His was a knowledge that was gained by experience and by the passing on of accumulated knowledge, gained in a similar way, from father to son or from master to apprentice.

As botany and medicine continued to develop separately there came gradually a complete separation of the work of the physician and the botanist. The science of pharmacognosy arose to take the place of the botany of the herbalist. A great many plant drugs once widely used are no longer employed in medicine, but others that have been used from early times are still counted among our valued remedies. Some of them grow in the fields and along the roadside. The pharmacognosist must study them all. Three common ones will be discussed in this brief paper.

For the layman, an interest in these plants can properly be only historical and botanical, since most herbal preparations are too potent to be prescribed or even experimented with by the unskilled. Some very common herbs are highly dangerous. Each herb has its own indications for use. Successful employment of it must depend upon careful prescribing, appropriate method of administration, proper preparation and correct dosage. It is for this reason that we point out that this paper is not to be considered in any sense an encouragement of self-medication. It is the direct opposite. "He who treats himself has a fool for a doctor."

Jimson Weed

Jimson Weed is a member of the Solanaceae family, the family to which the ordinary potato, tomato, tobacco, and other important food and medicinal plants belong. Its scientific name is Datura stramonium. The genus Datura consists of fifteen species that are found distributed throughout the warmer portions of the whole world. The original home of stramonium is not known with certainty. Its seeds, which are very retentive of life, are rather small and therefore well adapted for wide distribution. They have sometimes been found in earth put on ships for ballast. In this way and by various other means the plant has spread to all parts of the world except the colder regions.

Jimson weed has a long history as a medicine and as a poison. The early settlers at Jamestown, Virginia, searching for pot herbs, used this plant with fatal results. They warned others of its dangers, thus establishing it under the name Jamestown weed. Jimson weed is a variation of this early American name. The Jamestown settlers themselves gave it the name "devil's apple." The name "thornapple" is probably of old-world origin.

In early times thornapple was reputed to be used by witches as an aid in their incantations, and during the time of the witch and wizard mania in England it was extremely unwise for anyone to grow it in his garden. Browsing animals as a rule refuse to eat jimson weed, being repelled by its bad taste and its disagreeable odor, which accounts for the common name of stinkweed. Its presence in fields and pastures is, therefore, not really dangerous to domestic animals. Among human beings the greatest number of accidents has occurred among children who have eaten the half-ripe seeds which have a sweetish taste.

For use as medicine the leaves, seeds, stems and flowering tops all have been employed. The leaves and flowering tops are official in the *United States Pharmacopoeia*, one of our legal standards for drugs, under the title Stramonium. All the parts of the plant contain larger or smaller quantities of such important medicinal alkaloids as hyoscyamine, atropine and hyoscine (scopolamine), to which the plant's therapeutic

(Continued on Page One Hundred and Twenty)

Photograph by Robert Turriff Hance

NEW BOOKS

Youth Looks at Science and War

• A Collection of Science Essays. Published jointly by Science Service, Washington, D. C., and Penguin Books, Inc., New York. 1942. viii + 133 pp. $0.25.

This little booklet gives science instructors everywhere a peep at the results of some of the best science teaching being done in the secondary schools of this country. Every teacher should read it. So should his pupils. All will find inspiration in it.

In the book are collected the essays on "How Science Can Help Win the War," written by the nine girls and thirty-one boys who were winners of trips to Washington in the first annual Science Talent Search conducted this year by Science Service and the Science Clubs of America. The search was financed by the Westinghouse Electric and Manufacturing Company, which distributed 20 Westinghouse scholarships among the trip winners. The science aptitude examination, a 100-question reasoning test which was administered to each of the 3,200 contestants, is printed in an unabridged form, with the answers carefully concealed. Science teachers will be glad to use it to test their pupils. They might use it on themselves. The results could be surprising! *H.C.M.*

General Chemistry

• By LEONA E. YOUNG, Mills College, and C. W. PORTER, University of California. Prentice-Hall, Inc., New York. 1940. xi + 644 pp. $3.50.

This is a well made and attractively illustrated college textbook for beginners. It is admirably suited for use in classes whose members take chemistry as a tool course, but it would not be wholly suitable for chemistry majors. Some of the additional material such students need, however, is included in the 34-page supplement which is a part of the book.

At times the authors have not hesitated to depart from the traditional order, which is probably a good thing. The material is presented in 21 Units with from two to five Parts in each Unit. Questions and exercises are found at the end of each Part. Students will like the clear and attractive style, the careful explanations, and the many good half-tones, line drawings and diagrams. *H.C.M.*

The Dictionary of Philosophy

• *Edited by* DAGOBERT D. RUNES. 2nd Edition. Philosophical Library, Inc., New York. 1942. 344 pp.

This book is, to say the least, all that its editor claims for it. The astounding element about it is its compactness into a handy volume, all-embracing in content, clear in exposition, objective in viewpoint, and ear-marked by a correctness that is inescapable.

The editor has used unusual keenness in choosing the contents of the *Dictionary* and in selecting the authors best suited for a concise exposition of each subject discussed.

The teacher, the student or the layman will find the volume invaluable in his philosophical studies, and will save time and labor by having it at hand. The space given is always in proportion to the philosophical and historical importance of the subject; and research is made easy by bibliography and quotations.

This less-than-four-hundred-page volume definitely fills up a lacuna in the English language, as far as the field of philosophy is concerned.

REV. JAMES F. CARROLL, C.S.Sp., S.T.D.
Dean, Graduate School, Duquesne University.

Comparative Vertebrate Anatomy

• *By* LIBBIE HENRIETTA HYMAN, Research Associate, American Museum of Natural History. The University of Chicago Press. 2nd edition. 1942. 544 pp. $3.50.

This is anatomy working before the eyes of the student. Laboratory guide and text combined, encyclopedic in scope and brilliant in brevity, this book has no present equal. It is likely to do much to encourage a return to a fundamental study of morphology that has been so generally lacking in the training of this century's experimental biologists who too often know not with what they work. *R.T.H.*

Teaching in the Secondary School

• By M. L. GOETTING, Baylor University. Prentice-Hall, Inc. New York, 1942. xiii + 519 pp. $3.25.

This is an excellent book to put in the hands of prospective secondary school teachers for it gives them a clear and truthful picture of the work they are to do. It discusses not only their classroom duties, but the extracurricular activities in which they may be expected to participate as well.

In-service teachers will find the book informative, helpful and more than all else, stimulating. The author knows what he is writing about. Teachers will like his sound common sense, his easy approach, and the numerous practical helps he provides, although on the whole the book is concerned with fundamentals rather than with detailed methods. Its six main divisions are: The Learning Situation; The Objectives of Secondary Education; Organization of Instructional Procedures; Instructional Planning; The Unit Plan of Teaching; The Guidance Functions of the Teacher.

Quoting from the Preface: "In point of view, the book attempts to be progressive, and its interpretations and points of emphasis are such that the teacher will be able to avoid the many undesirable tangents of modern progressive education." *H.C.M.*

Young Americans' Dictionary

• *By* S. JOHNSON, D. Sc. Philosophical Library, New York. 1942. 352 pp. $3.00.

There is nothing which contributes so greatly to reading ability as correct understanding of words and word relationships. This dictionary has been published for the purpose of helping pupils of the elementary and high school grades make sense of what they read, write, and say. The reviewer believes it to be an excellent medium through which they may obtain an understanding of language and language patterns. Its clear simple explanations, concreted by numerous examples, should help pupils to develop an important fundamental skill—"art in the use and understanding of words."

The type faces selected for the book are attractive and of a size suited to the eyes of youth, a factor neglected in certain recent publications. The dimensions of the volume are such that it may be handled easily by younger as well as older pupils. The excellent definitions provide a maximum amount of clearly defined information in a minimum amount of space. The concrete example which supplements each definition adds immeasurably to the clarity. The usefulness of the book would be increased by the addition of lists of antonyms, synonyms, and homonyms, either with the individual definition or in appendices. Many of the language difficulties of youth arise from the neglect of this particular understanding of words spelled alike but of different meaning, of words spelled differently but having the same meaning, and of words of diametrically opposite meanings.

KATHRYN H. BURKHART, Ph.D.
Department of Elementary Education, Duquesne University.

Education in the Elementary School

• By HOLLIS L. CASWELL, Teachers College, Columbia University. American Book Company, New York. 1942. xiv + 321 pp. $2.50.

This book has great possibilities for service in the areas it covers. In it are discussed the major problems and issues facing elementary education, including the changing modes of living, the disruption of family life, and the emotional reactions of elementary children, due to wartime changes. The treatment is based on extensive research such as has not previously been attempted in the elementary school, and Dr. Caswell warns that the study of elementary school problems must be continuous so that organization and curriculum building may meet changes as they arise. He stresses the fact that classroom teachers should have a major part in this work.

The aims of education are discussed in considerable detail and analyzed from the point of view of the child in our American Democracy. There is a continuous effort throughout the book to show that the conclusions reached are more than the fanciful dreams of an educational theorist. The findings of research are used freely to support the positions taken.

This book will be of assistance to elementary teachers in service, and most valuable for students preparing to be teachers. It will help both groups to clarify their own aims of education, and give them a clear view of what has already been done and what more may be expected of our elementary schools.

KATHRYN B. REDMAN, D.Ed.,
Department of Elementary Education, Duquesne University.

Introductory Organic Chemistry

• *By* E. WERTHEIM, University of Arkansas. The Blakiston Company, Philadelphia, Pa. 1942. vii + 482 pp. $3.00.

Experiments in Organic Chemistry

• *By* E. WERTHEIM. The Blakiston Company, Philadelphia, Pa. 1942. x + 215 pp. $1.35.

This organic chemistry, which is a revision of an earlier text, is designed primarily for use in short courses for students who need a knowledge of organic chemistry as a background. It will serve adequately as a basic text for such classes. Chapters on the digestion and absorption of foods, metabolism, nutrition, and foods and dietary necessities extend its usefulness. In the opinion of the reviewer, however, the advisability of attempting to cover this material in one semester along with all the factual information that is needed for even the most elementary course in organic chemistry, is highly questionable. An Appendix, containing a glossary of chemical, medical and biological terms, a list of inorganic definitions, a list of reference books, a table of foods, and a section on stain removal, is a worth while feature of the book. Other noteworthy features are the use of pictures of molecular models to supplement structural formulae, and the inclusion of numerous flow sheets illustrating the reactions, preparations and relationships of organic compounds. Each chapter includes a list of review questions of the discussion and objective types. The chief weaknesses of the text appear to be the limited emphasis placed on general methods of preparation and type reactions, and the approach to complex natural products from the standpoint of occurrence rather than structure.

The laboratory manual offers a wide selection of experiments for a one-semester course, including several experiments in biochemistry. Good preliminary directions are given, and a variety of compounds and reactions are handled to familiarize the student with as many compounds as feasible in a course of this type. Most of the experiments can be completed in one laboratory period or less. The manual is wire-bound in limp leatheroid so as to lie flat, a convenience in the laboratory.

WILLIAM R. LLOYD, Ph.D.,
Assistant Professor of Chemistry, Duquesne University.

Principles of Flight
Principles of Aircraft Engines

• *By* BERT A. SHIELDS, Lt. Cmdr. U.S.N.R., Polytechnic Institute of Brooklyn. McGraw-Hill Book Co., Inc., New York, 1942. $1.88 each.

These books, which reflect the background and experience of a skilled aviator and successful teacher, fill a present-day need for a teachable, sound, and not too highly technical discussion of some of the fundamentals of flying. They are the first of a four-book series. The others are to deal with aviation meteorology and air navigation.

Adapted to the needs of secondary school students in content and organization, the two books under discussion should do much to dispel the fear of ground school subjects that just now seems to prevail even among mature trainees. Written in an easy, readable style and profusely illustrated, they will help to popularize the study of aviation in high schools. Students who master their contents will be well along the way to a useful understanding of much of the material that must be at the finger tips of all air pilots.

After giving a brief account of the development of aviation, *Principles of Flight* discusses the anatomy of the airplane, forces involved in flight, stability and control, safety in the air, and the instruments used in flying. The pupil is instructed how to fly, starting with the initial flight and proceeding to acrobatics and precision flying. In *Principles of Aircraft Engines* the plane's power plant is studied in detail and such points as carburetion, ignition, lubrication, propellers, and engine operation and servicing are discussed.

ANDREW J. KOZORA, M S.,
Ground Instructor, C. A. A.,
Duquesne University.

Experimental Physics

• By D. H. BELLAMY. Chemical Publishing Company, Inc., Brooklyn, N. Y. 1941. 255 pp., 149 illustrations. $3.75.

The purpose of this book is to describe experiments in physics which, duly performed and understood, will prepare the student to pass the examinations of the various Examining Bodies of Great Britain for Higher School Certificates. Included with the descriptions of experiments are examination questions similar to those asked by the Examining Bodies or actually taken from their lists of questions. There is an introductory chapter of hints on practical work and concerning points which should be observed in trying to pass the examinations. There are several mathematical tables and tables of physical constants.

The narrow expressed purpose of the book should not be taken to mean that it has little interest for American teachers, however. There are 109 experiments, briefly but adequately described. Some of these are usually not found in our laboratory manuals. All are suitable for classes in elementary college physics.
G.E.D.

The Physical Universe

• *By* BROTHER AUGUST LEO and BROTHER CONRAD GABRIEL. Edwards Brothers, Ann Arbor, Michigan. 1941, 312 pp. $3.50.

In the present edition (the first), this volume, as stated by the authors, is to serve "as a testing device for the material presented and as an initial effort upon which to build." In our opinion, the effort is very creditable. The authors aim "to give the students of this course at Manhattan College an understanding and appreciation of the marvelous order which exists in the physical universe." They believe that now "science should work hand-in-hand with the Church in ridding the world of superstition," and that a knowledge of science and the scientific method should be of cultural and practical value, regardless of the major interest of the student. With these aims and views scientists will be generally in hearty agreement.

The general topics covered and their order of presentation are as follows: the earth and the solar system; geology and meteorology; heat; electricity; sound; chemistry; light and other radiations; astronomy. The text is well written. The authors seem to have resisted the usual temptation to sacrifice accuracy for popular appeal, yet have managed to write in a very interesting way about the world and the universe in which we live. Study questions, of the completion type, are included. Well-chosen diagrams and photographic reproductions illuminate the text. Some of the topics treated are quite advanced for a treatise of this kind, notably certain topics in light and atomic structure. It might well be objected that these probably will register only slightly in the comprehension of the student, because of the necessarily brief treatment. But the teacher may omit these topics or add supplementary discussions.
G.E.D.

Weeds as Medicines

(Continued from Page One Hundred and Seventeen)

effect is largely due. The leaves are rich in potassium nitrate. Both the wild and the cultivated plant contain the same constituents and may be used medicinally, but the cultivated plant is superior and commands a higher price. Although a few American farms are cultivating jimson weed for the market, most of our medicinal supply has been imported from central Europe. Undoubtedly the War will stimulate an increased production in the United States.

Jimson weed is used medicinally in the form of the powdered crude drug and in the form of liquid and solid extracts. Neither drying nor boiling destroys its active constituents. How potent this drug is may be judged from the fact that the alkaloids found in it, especially atropine and hyoscine, are among the most powerful drugs in common use. In suitable doses stramonium preparations and the alkaloids derived from the plant act as nerve sedatives and give relief from certain types of pain (narcotic). A local sedative effect is also obtained by the application of certain preparations to the skin or mucous membranes. Larger doses dilate the pupil of the eye, an effect which may also be obtained by local application of weak solutions of the salts of atropine or hyoscyamine. Poisonous doses of the plant or its alkaloids cause dimness of sight, dilation of the pupils, giddiness and delirium, or even intense maniacal excitement. There may be marked muscular tremors, eventually followed by death from respiratory failure. Since treatment of severe poisoning is difficult, it is often unsuccessful. Many fatalities are on record.

Jimson weed is used in the treatment of asthma and croup. It has been employed to allay nervous irritation in various forms of hysteria. Solutions of atropine and hyoscine are used to dilate the pupil of the eye in preparing it for an operation or in the treatment of an internal inflammation. Hyoscine hydrobromide in doses of 1/120 of a grain is used as a sedative. In combination with morphine, hyoscine has been used in obstetrics in the treatment known as "twilight sleep." This combination has a deep sedative action on the brain and spinal cord, causing temporary loss of memory and insensibility to pain. The crushed herb applied as a poultice has been employed to relieve the pain of gout and rheumatism. The powdered weed has been mixed with tobacco and other substances for smoking in a pipe or in cigarettes for the relief of asthma. Its use in this way is not without danger.

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Catnep

Catnep (Nepeta cataria), also known as catnip and catmint, has a long and interesting history as a medicinal herb and condiment. The dried leaves and flowering tops are official in the *National Formulary* under the title Cataria. This common plant is a member of the Labiatae, the great square-stemmed family of plants to which peppermint and spearmint belong.

Catnep grows wild in the British Isles, Europe, and some parts of Asia and North America, usually being found near dwellings. It is extensively grown as a garden plant, especially in England and in continental Europe.

The root is a perennial and sends up erect and branched stems which reach a height of three feet or more when conditions are favorable. The stems are very leafy, and both stems and leaves are covered with a whitish down that gives the whole plant a grayish appearance. It is in bloom from July to September, its white or purplish-white flowers growing on short stalks in dense axillary and terminal whorls at the ends of the branches.

Catnep has a characteristic and rather pleasant odor which has a strange fascination for cats. Rats have a special dislike for the plant, and it has been suggested that various crops might be protected from rats by growing catnep around them as a screen.

Infusions of catnep produce free perspiration. They are used to treat colds and fever. There is also a sedative effect which is useful in restlessness, colic and nervousness. The infusion, made by steeping the herb with water, is called catnep tea. The water should be brought to a boil, the herb added, and the mixture then set aside for several minutes. Boiling is undesirable since it causes some of the important constituents to volatilize. The young tops, made into a candy-like preparation with syrup or honey, may induce quiet sleep in children. Old writers recommend that the juice be drunk in wine for bruises; that the green leaves be bruised and made into an ointment for hemorrhoids, and that water in which catnep has been boiled be used to remove scabs and scurf. A poultice made of the flowering tops and applied hot will sometimes relieve painful swellings and hasten the ripening of boils. In France, catnep leaves and young shoots are used to season foods. Catnep is commonly grown there in vegetable gardens. Before tea was introduced into England, the peasants used a tea brewed from catnep. Catnep root, when chewed, was thought to make a person fierce and quarrelsome. There is even a legend of a certain hangman who never could screw up his courage to the point of hanging a man until he had partaken of catnep root!

Dandelion

The dandelion (Taraxacum officinale) is at home in all parts of the North Temperate Zone, growing in pastures, meadows and waste ground and, to the distress of many home owners, on lawns. Since it is a prolific seed producer it is widely disseminated and hard to eradicate. Farmers find it a troublesome weed.

Arabian physicians used dandelion as a medicine in the Tenth and Eleventh Centuries. There are frequent allusions to it in the Welsh medical writings of the Thirteenth Century. In India it is a cultivated plant.

Most persons recognize dandelion plants with ease. Its thick tap root sends up a tuft of long leaves that form a rosette lying close to the ground. Sometimes its leaves are deeply cut into tooth-like segments. Other leaves may be less segmented and almost entire. The leaf surface is shiny and without hairs. The shining, leafless flower-stalk, rising straight from the crown, is hollow, and when the flowers are picked a milky juice exudes from the broken edges of the stalk. This juice, which is found throughout the plant, causes a brown stain that is rather difficult to remove when it comes into contact with the skin.

The composite flowers are made up of numerous strap-shaped florets of a bright golden yellow color. Each tubular floret produces a copious supply of nectar. This provides an incentive for the visits of the honey bee and numerous other insects. Matured flower heads contain many seeds, each crowded with a tuft of silky whitish hairs that facilitates dispersal of the seeds by the wind. Large gossamer balls of the tufted seeds are shed from the matured flower.

Young dandelion leaves make an excellent salad green, either alone or in combination with lettuce, chives, celery or other greens. Full grown leaves have a bitter taste. If the flower buds of cultivated plants are removed when they appear and the older leaves are kept cut off, the plants can, in protected locations, be made to bear salad leaves throughout the winter. The young leaves are often boiled, like spinach, and served as a vegetable.

Dried dandelion leaves are used in digestive drinks and beers that are popular in England, and in parts of Cannada. Here also the flowers are used to prepare dandelion wine, which is prized as a "blood tonic." In Wales the roots of cultivated plants are grated or chopped and mixed with the young leaves in a salad. From the cleaned, roasted and powdered roots the English sometimes make a dandelion "coffee." It is a general stimulant, which is slightly laxative. It increases the activity of the kidneys. It does not promote wakefulness.

Only large, fleshy, well formed roots should be selected for medicinal use. Those from plants two years old are preferred. The age of roots cannot be told with certainty except in the cultivated plant, although older roots tend to divide into several heads at the crown. At present dandelion is not as popular a medicine as it once was, but it finds some use as a bitter, an appetizing tonic, and as a mild laxative. It has been used in numerous "patent" medicines. It is official in the *British Pharmacopoeia* and in our own *National Formulary*. ●

Metallic Lead Products

(Continued from Page One Hundred and One)

age composition of the coating being 80 per cent lead and 20 per cent tin. It is applied by a simple hot-dip process, the sheets being first cleaned by pickling and then passed through a bath of the molten lead-tin alloy. Terne plate is now being widely used instead of tin plate to make paint cans and other containers for similar products.

Practically pure lead coatings are also applied to steel and copper by virtually the same process. Since lead does not readily "wet" or alloy with steel and copper, a small amount of tin, say 1 per cent or less, generally is included in the lead to improve the bond.

So numerous and varied are the metallic products made from lead that it is impossible to describe them all. With its characteristic softness and low melting point, it is easily fabricated by a number of methods, the most important of which have been described. These processes, which include rolling, extrusion, casting and stamping, produce with variations a vast quantity of different products for different purposes.

We list here a summary of some of the properties of lead that affect its fabrication and use as a metal as distinguished from its employment in the form of chemical compounds.

Density:
- Pure cast lead, 20° C. ..... 11.34 gm. per cu. cm.
- Rolled Sheet, 20° C. ..... 11.35 to 11.37 gm. per cu. cm.
- Ordinary, 327.4° C. just solid ..... 11.005 gm. per cu. cm.
- 327.4° C. just liquid ..... 10.686 gm. per cu. cm.
- 550° C. ..... 10.418 gm. per cu. cm.
- 800° C. ..... 10.132 gm. per cu. cm.

Hardness: Moh's scale 1.5

Weight:
- Pure cast lead, 20° C. calculated ..... 0.4092 lb. per cu. in.
- equivalent to ..... 707. lb. per cu. ft.
- Rolled, (density, 11.37) calculated ..... 709. lb. per cu. ft.
- Liquid, 327.4° C., calculated ..... 666. lb. per cu. ft.
- Sheet Lead, 1 ft. sq. x 1/64 in. thick weighs approximately ..... 1 lb.

Volume of 1 lb. of cast lead 20° C., calculated ..... 2.44 cu. in.

Melting point ..... 327.4° C. (621° F.)

Latent heat of fusion, per gram ..... 5.47 gm. cal.

Latent heat of fusion, per mole ..... 1133 gm. cal.

To melt 1 lb. of lead, heating from 20° C. requires ..... 7100 gm. cal. or 28.4 B.T.U

Coefficient of linear expansion (—190 to 19° C.) ..... .0000265 per deg. C.

Coefficient of linear expansion (17 to 100° C.) ..... .0000293 per deg. C.
equivalent to ..... .0000163 per deg. F.

Coefficient of cubical expansion (liquid at melting point to 357° C.) ..... .000129 per deg. C.

Coefficient of cubical expansion calculated (17 to 100° C.) ..... .0000879 per deg. C.

Increase in volume from 20° C. to liquid at melting point ..... 6.1 per cent

Decrease in volume on solidifying ..... 3.85 per cent

Increase in volume on melting ..... 4.01 per cent

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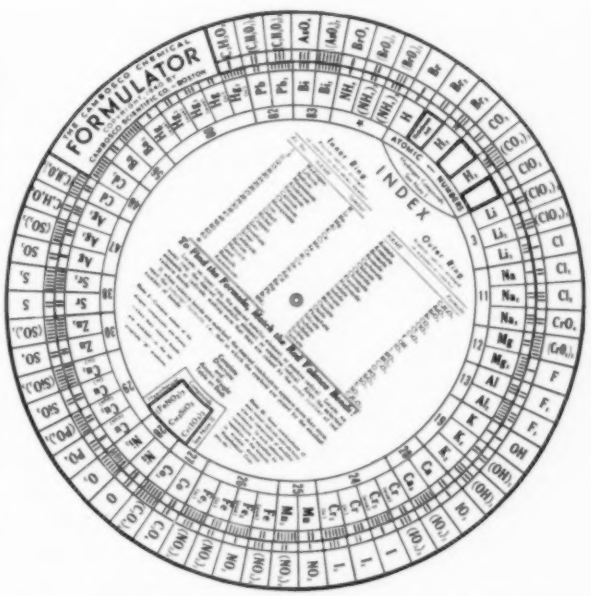

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Young's Modulus of Elasticity.....2,560,000 lb. per sq. in.

Poisson's ratio of transverse contraction to longitudinal extension under tensile stress.....0.4 to 0.45

Compressibility, 20° C., per unit volume, per megabar..2.2 to 2.5 x 10^{-6}

Ultimate tensile strength:
Soft lead.....1400 to 1700 lb. per sq. in.
Chemical lead.....2300 to 2800 lb. per sq. in.
Wire, hard "drawn".....3130 lb. per sq. in.

Effect of Temperature on Tensile Properties:
(Lead, annealed at 100° C.)

Temperature ° C.	Temperature ° F.	Tenstile Strength kg./mm²	Tenstile Strength lb./in.²	Elongation per cent	Reduction per cent of area
20	68	1.35	1920	31	100
82	180	.8	1140	24	100
150	302	.5	710	33	100
195	383	.4	570	20	100
265	509	.2	280	20	100

Fiberglas, a Basic Material

(Continued from Page One Hundred and Eleven)

Use of Fiberglas yarns, and all other forms of Fiberglas, for non-war purposes has been sharply curtailed or suspended for the duration, due to the demands of the war program. Today, more than 91 per cent of the total production of Fiberglas in all its forms is furnished under Army, Navy and Maritime Commission specifications.

The electrical industry, a chief source of power for the entire war program, is a principal user of Fiberglas in its textile forms. In the form of tapes, cloths, braided sleevings and tying cords, Fiberglas is used for the insulation of electric motors, generators, transformers and other types of operating and distributing equipment.

When it is used with suitable varnishes or impregnants, and in accordance with sound engineering techniques, relatively thin layers of glass fiber insulation provide the insulation characteristics required. Because of its high resistance to heat it enables motors to operate at higher temperatures and greater overloads, than when alternative insulation materials are used.

Because Fiberglas insulation can be used in relatively thin layers, it makes possible material savings in both the size and weight of motors and other electrical equipment. Class B motors, built on frames a size smaller than was formerly standard for a given output, are examples of the many instances in which it has been possible to combine durability and stamina with space and weight saving.

Fiberglas-insulated motors are widely used on shipboard, and in helping to keep our bombers and fighter planes flying over all the continents and the seven seas. Fiberglas-insulated generators are providing power for tanks and other Army motorized equipment. Fiberglas retainer mats are used in batteries for tanks, armored cars and trucks, and in the storage batteries on which submarines operate.

Fiberglas in the Surgical Field

Among the most interesting uses of Fiberglas are three in the surgical field. A strip of tape woven of Fiberglas yarn is being used as a filter in the apparatus employed to give blood plasma transfusions to soldiers wounded in battle. The close weave of the tape blocks even minute particles, but permits free passage of the fluid, for, being glass, the fibers do not swell under moisture.

Because Fiberglas yarn may be formed of radio-opaque glass, surgical sponges are being made with a single strand of this yarn interwoven in the cotton sponge. The Fiberglas yarn makes it possible to determine with the X-ray the presence of a sponge in those cases where post-operation complications lead to a suspicion that a sponge may have been left in the wound.

Fiberglas is being used experimentally as a suture material for the sewing of wounds. The Fiberglas suture is made of standard continuous glass filaments drawn to such fineness that 204 filaments are combined to make a strand measuring 45,000 yards, more than 25 miles, to the pound. In appearance the suture looks like silk.

The results of the experimental use of Fiberglas sutures in both human and animal surgery indicate that they may be expected to find a wide field of usefulness as a material which, because it does not cause irritation of body tissues, tends to minimize the infection of wounds following operations.

Production of blood plasma filters, tracer threads for surgical sponges, and surgical sutures represents only a tiny fraction of the total output of Fiberglas. Under the pressure of war demands, manufacturing capacity has been increased so greatly that enough Fiberglas yarn to meet a century's need for Fiberglas for surgical uses could be turned out in a few hours.

Nevertheless, this little fraction represents humanitarian uses of what an Army physician has called "benign" Fiberglas, and it foreshadows the day when, in a world no longer at war, Fiberglas will be applied to making men's homes more comfortable, their lives safer, and their machines more efficient in meeting their peace time needs. ●

Hierarchy of the Sciences

(Continued from Page One Hundred and Four)

Speaking of scientists he says "Oh, if as much diligence were exercised in the building of morals . . . they want to cultivate with precision subtleties which they can never penetrate . . . Oh, vain showing off . . . useless curiosity . . . far be it from me, most sweet Jesus, for if there is any good in me, it is from Thee."

Now, that is very beautiful, and from the point of view of piety it is a very praiseworthy prayer of humility. But to define a rooster, the same author consults the Justinian Code, and he says that a rooster can lay eggs in his old age. He defines hippopotamus *serpens aquaticus bubulis infestus magnae quantitatis*, "an aquatic serpent of huge size that is hostile to cows." Man is an upturned tree; he has hair for roots.

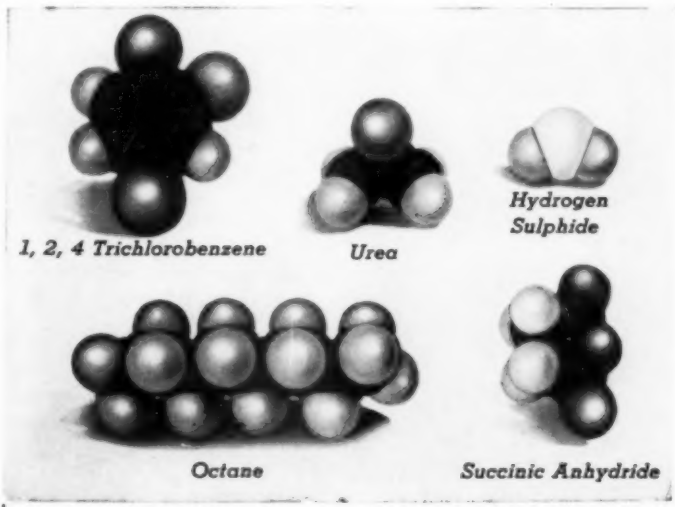
That is what happens when science is confused with sentimental piety.

But extremes meet. Here are some 1941 examples of piffle that is paraded in the name of modern science.

> "The livingness of the universe was a commonplace before the sciences began to nibble away at the mysteries. The deadness of the universe—its sheer materiality—is far more near a commonplace today. The divine purposiveness of the universe was a commonplace when our knowledge of it was chiefly a vast ignorance. Its purposeless impersonality is more nearly as commonplace in these days, when telescope and microscope have revealed more of its structure and processes. It is no wonder that the clerics refused 'pertinaciously' to look through Galileo's telescope. They sensed perhaps, what must happen to the minds of men when mysteries are turned into facts." (Harry A. Overstreet, in *Science, Philosophy, and Religion*, p. 185.)

I do not know which of the two men you would care to choose, but if Professor Overstreet's science is the best we can get after 400 years of science, I think that, in some cases at least, Alexander of Neckam was right when he defined man as "an upturned tree with hair for roots."

In the recent meeting of the Conference on Science and Philosophy and Religion some very serious scientist proposed that Roosevelt and Churchill be kicked off their thrones and replaced by scientists. Imagine the President of the United States ruling the nation by chemical formulas! And if we want to see what science does when it usurps the place of wisdom in all its forms, let us look at what an absolute biological concept has done in Germany, and an absolute mechanical concept has done in Russia.



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May I suggest that after we make the needed distinction between the philosophy of nature and the natural sciences, we all work together to bring back the divorced couple of science and wisdom where they belong. ●

Frequency Modulation

(Continued from Page One Hundred and Sixteen)

some particular station will also receive any noise signals blanketing the part of the dial to which the set is tuned. Notice that the noise signal is present in both the FM as well as the AM receiver.

But the noise is not heard on the FM receiver because the noise can be separated from the FM carrier wave without losing the speech or music. With the conventional AM system, however, the noise cannot be separated from the program carrier wave and therefore is reproduced along with the speech or music.

The reason why the noise can be separated and sidetracked in the FM set and not in the AM can be shown on the accompanying chart. (Fig. 5.)

At the FM transmitter, the sound or program wave is used to change not the amplitude but the frequency of the carrier wave. From the AM transmitter, the radio carrier wave sent out is constant in frequency and the sound is used to change the amount of power sent out from the station's antenna.

The noise signals which are changing in strength (amplitude modulated) combine with both the FM and AM carrier waves as shown by the jagged lines or peaks on top of the carriers. Thus the FM carrier is no longer only frequency modulated by the sound, but also is amplitude modulated by the noise. The AM carrier is further amplitude modulated by the noise. Note carefully that the noise and the sound have the same effect on the FM and AM carrier, namely to change its amplitude, or power.

Now in the FM receiver the amplitude modulated component caused by the noise can be eliminated with the limiter circuits which prevent changes in amplitude of the signal from going on into the loudspeaker. Of course, these amplitude changes due to the noise in an AM carrier cannot be "erased" with such a limiter circuit for it would also "erase" the desired sound or program, which is also carried by the amplitude modulation.

We ordinarily think of a musical tone as a sound caused by vibrations at some definite rate of frequency. The faster the vibration the higher the tone. Thus the lowest note on a standard piano has a frequency of only 26 vibrations or cycles per second, while the highest has a rate of 4,138. Few, if any instruments, have greater range. Hence if tone quality were only a matter of reproducing sound vibrations up to 5,000 per second, as can be done by any first class radio receiver from a standard amplitude modulated network program, FM would bring little improvement, aside from its freedom from noise and its greater fidelity throughout the tonal range.

Tone quality, however, is determined by an additional series of sound vibrations called overtones. When a violin string vibrates 260 times per second (middle C) it is also vibrating in two, three, or more equal segments to produce overtones of 520, 780, 1,040, etc., vibrations. It also causes one or more of the other strings to vibrate at varying rates. The result is a fundamental tone plus a complicated series of overtones which give color and quality to the musical note. A really pure tone without these overtones is dead and unpleasant; moreover, if we heard only pure tones, all instruments would sound alike. It is the number and relative intensity of overtones that give quality and richness to the music.

Different instruments vary in the number and relative intensity of overtones; the high notes of a violin produce overtones up to 13,500 vibrations per second, while even the rumbling bass tuba has overtones of 6,000. With fidelity of reproduction limited to 5,000 cycles or vibrations per second, as on the average AM network program, there is certain to be some distortion or discrimination in the various overtones. Low notes, produced with virtually all overtones, will have different quality than high tones of the same instrument which have most of their overtones cut off. On some notes, instruments will lose their individuality, with violins sometimes sounding like clarinets, etc. It is FM's faithful reproduction of all sound vibrations from 20 to 15,000 per second that gives each instrument its marvelous clarity. (Fig. 1.)

A rather new term, "dynamic range," is being used to describe the ability of the FM system to reproduce the very softest to the very loudest sounds, without the compression which must be used with the AM system.

A symphony orchestra has a dynamic or volume range of approximately 100 decibels. This corresponds to a power change of ten billion to one. In the AM system the program must be kept above the background noise level and, at the other extreme, below the peak power rating of the station. Thus weak passages have to be made louder and strong passages softer. This "compression" of the dynamic range is essential to AM operation. Because of the absence of background noise in the FM system, the weak passages do not have to be made louder and the strong passages only shift the frequency further with no danger of damaging the equipment with a power overload, which might occur on AM transmitters.

It should be pointed out that while in many cases perfectly acceptable reception can be had by merely hooking up a piece of wire to your FM receiver or translator, a di-pole antenna is still to be recommended for FM reception. No doubt there will be many local-

ities where a di-pole antenna erected at a good height will be absolutely necessary to obtain good reception. Our habits with the old AM type of receiver cannot necessarily be carried over to the FM type if we are to expect good results from the latter. (Fig. 2.)

Conclusion

In the present scheme of things, FM while making possible high fidelity transmission and interference-free reception has the outstanding disadvantage of being available only for what might be called local coverage. Frequency modulated stations, as are many of the smaller standard broadcast stations, are found located in the centers of metropolitan areas where a large number of listeners are concentrated in a comparatively small space.

Already the larger metropolitan centers are adequately served by radio, and the addition of frequency modulated transmitters merely offers a duplicate service. With some 875 standard broadcast stations in the country, only 25 of these stations are the clear-channel type upon which rural listeners depend for their radio service. We have, therefore, approximately 850 stations serving only about 20 per cent of the country's area. Without the 25 clear-channel stations in operation, 80 per cent of the couutry in which some 53,000,000 people live would be plunged into a radio blackout. In this area are some 15,000 incorporated towns with less than 5,000 population. Thousands more are unincorporated. In all these thousands of small towns and villages, there are only 164 daily newspapers and a correspondingly low number of moving picture houses and other means of spreading news and entertainment. In other words, this larger percentage of our country depends for its news and contacts with the outer world on a very small number of amplitude modulated or standard broadcast stations.

As we see it then, FM does not have its function directed toward a larger national means of radio service, but it does offer a new means whereby city listeners can obtain a clearer and perhaps more lifelike radio rendition of their favorite orchestras and speakers. It lends itself naturally to the more dignified musical presentations and it is quite likely to be a favorite means of reception by the music lover.

If we wish to look into the future and we let our imagination wander, more can be said for FM. Radio is gradually working toward the ultimate in radio entertainment, television. While it might not be safe to say FM is definitely linked with the future of tele-

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vision, it can be said many of its attributes fit very nicely into the television structure. FM and television both operate in the ultra-high frequency section of the frequency spectrum. Any experience and knowledge gained in this somewhat unexplored region will be helpful to the engineers and can be directly adapted to television transmission when this field is open.

FM has a definite advantage of being able to transmit a wide band of frequencies. This affords higher fidelity for the listener in his aural reception. There is a debatable question as to whether the average listener wants higher fidelity, or even whether he is qualified or trained sufficiently to recognize good quality when he hears it. It does present, though, a means for transmitting a wide band of frequencies, and television in its operation must transmit over a wide band in making possible a good picture.

The noise-free characteristic of FM lends itself well to faithful transmission of either aural or visual effects.

The freedom from interference inherent in FM permits a number of FM transmitters on the same frequency, spaced at regular intervals across the country. This not only results in a saving of frequency allocation space, but also leads to the thought of radio relay links across the country instead of the present telephone circuits.

The presenting of television shows represents an entirely new conception of dramatic endeavor, one hour of television being many times more costly than a similar hour of simple aural presentation.

There are only two means which present themselves for the broadcasting of chain television shows. The first is the "canned" process whereby films are distributed throughout the country. The other is the more desirable live instantaneous broadcasting; but, unfortunately, this calls for some medium whereby wide bands of frequencies can be transmitted across the nation. Some progress has been made along this line in the construction of co-axial cables between cities, these cables having the property of wide frequency band transmission. Such a method is extremely costly and might very well be supplanted by FM transmitters spaced every 25 to 50 miles across the country, thereby acting as radio repeater stations comprising our television network of the future. ●

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Rating Papers

(Continued from Page One Hundred and Thirteen)

On occasion, a two-credit question involves a reaction that yields an unstable product, such as H_2CO_3. Assign full credit only when the question shows, correctly and properly, the dissociation products of the unstable compound. Assign one credit for the correctly balanced equation that shows the unstable product itself.

A second illustration is the reaction of sodium hydroxide and ammonium chloride. Assign full credit to this equation:—

$$NaOH + NH_4Cl \longrightarrow NaCl + NH_3 + H_2O$$

Assign full credit to these equations

$$NaOH + NH_4Cl \longrightarrow NaCl + NH_4OH$$
$$NH_4OH \longrightarrow NH_3 + H_2O$$

Assign *half* credit to this equation, and to other equations that yield unstable products:

$$NaOH + NH_4Cl \longrightarrow NaCl + NH_4OH$$

On occasion, simple equations that should be very familiar to all pupils are allocated one credit only. In such cases, assign *no credit* unless the equation is wholly correct.

Mathematical Problems. Credit is properly assigned to a correct method of solution, to correct arithmetic manipulation and to the correct unit in which the answer is expressed. The solution of some problems may involve more than one calculation. Do not penalize the pupil more than once for the same error. Assign proper credit for each correct part of an answer.

Some types of genetic questions may be classed as mathematical problems. Full credit is assigned to an answer to such a question only when the answer includes a key that describes the meaning of the symbols employed, and gives a correct interpretation of the diagrammatic scheme employed, whenever the question asks for an interpretation.

If a chemical problem requires that the pupil write an equation, assign one credit to the correct equation. Assign one credit to correct method, one to correct arithmetic answer, and one credit to the correct unit, unless the question itself specifies the unit of the answer. Partial credit may properly be assigned to each of these factors when it is correct.

Algebraic or other formulas are sometimes used in the solution of problems in physics. Assign *no* credit to an answer that consists *solely* of a formula, with no effort to apply it. Assign credit to correct method of

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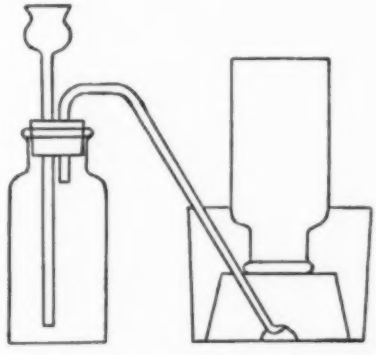

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solution (even though the formula may not be given), to correct arithmetic manipulation and to correct units. Arithmetic errors and errors in units are each penalized one unit of credit.

On occasion, a multiple-part problem question may be written in such fashion that the answer to one part of the question is used to obtain the answer to another part. Do *not* penalize the pupil more than *once* for an error. If an incorrect answer to one part is correctly used in a later part of the question, assign full credit to the second answer when it is *correct in every respect* save that due to the earlier error.

An illustration from a physics answer paper is here shown. Similar rating practice applies to similar types of answers in any subject. This pupil answer was given to question I, part II, of the June 1941 physics paper. The question reads:

"*a* A specific-gravity bottle weighs 30 grams. Filled with water the bottle weighs 130 grams. Filled with gasoline, the bottle weighs 110 grams. Calculate the specific gravity of the gasoline. (3)

"*b* A pump raises 200 cubic feet of the gasoline described in *a* to a height of 66 feet. How much work is done to raise the gasoline? (Density of water is 62.5 pounds per cubic foot.) (4)"

The answer reads:

"*a* Specific gravity

$$= \frac{\text{weight in air}}{\text{weight of equal volume of water}}$$

$$= \frac{110 - 30}{130 - 30}$$

$$= \frac{80 \text{ grams}}{100 \text{ grams}}$$

$$= 0.08 \text{ grams/cc}"$$

This answer is properly assigned one of the three possible credits, since the method of solution is correct. The error in arithmetic and the incorrect use of units should both be circled in red; one credit penalty applies to *each* error.

The pupil answer to the *b* part of this question follows:

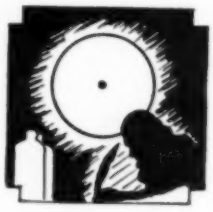
"*b* weight = volume × density
= 200 × 62.5 × 0.08
= 1000 pounds
work = force × distance
= 1000 × 66
= 66,000 Ans."

The answer is properly assigned three of the four possible credits. Full credit is assigned to the method and to the calculations, since they are wholly correct save for the error in specific gravity—an error already penalized. The answer should be expressed in foot-pounds; one credit is removed for failure to specify the unit.

An answer to a problem question that consists only of the numerical answer, unaccompanied by the calculations that lead to the answer, is assigned *full credit* when the answer is wholly correct. *No credit* is assigned an incorrect answer, unless the proper unit is given; then one credit is allowed for the correct unit.

On occasion, a Regents examination paper will include a question that requires two or more simple responses and to which *only one credit is assigned.* The question should be rated on a right-wrong basis . . . *no fractional* credit is to be assigned. The question "Name three allotropic forms of sulfur. (1)" illustrates this case.

To receive credit, an answer must contain *three correct* responses, for example, "rhombic, prismatic and amorphous." Do not assign fractional credits to such answers. ●



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Ceramics and the War

(Continued from Page Ninety-eight)

are the modern descendants of the old grindstone, made to run at speeds at which the latter instrument would have flown into a thousand pieces.

Modern abrasives are hard enough to grind rapidly the finest steels to precision measurements. Alumina produced from bauxites of too low grade for metal production, after fusing in the electric furnace, is the source of this important class of synthetic abrasives. Other abrasives still harder, include silicon carbide and those made of tungsten carbide and boron carbide. Corundum, either synthetic or natural, is also used for sapphire jewels in precision bearings for time bombs and split-second airplane instruments.

In addition to glass jars for food, clay-containing fibre cans have been developed for replacing the well known tinned steel can.

Today's war industry has caused new and increased demands for many ceramic materials: asbestos for heat-proof suits and gloves; magnesia, kyanite and topaz for refractories in steel production and other uses; limestone for a fluxing agent in processing metals; quartz in radio manufacture; graphite for molds in metal castings; pigments for paints; quartz sand for blasting; cement for dams, roads, airports, buildings, gun emplacements, and drydocks.

Where ceramic products play a minor role, they often fulfill a vital purpose. Necessary to the operation of the airplane is the porcelain spark plug. Boilers are lined with refractories for retention of heat and protection of their metal shells. Bleaching clays or "fuller's earth" are used in clarifying vegetable and mineral oils.

Limestone, the largest in point of tonnage among quarry products, in addition to its uses in metallurgy and chemistry, is a source material in the production of calcium carbide used indirectly for welding and in synthetic rubber production.

Mineral halite, or salt, the second in importance as a heavy chemical, serves as a raw material for the chemical industry.

The Federal Government has recently placed a ban on gold mining to release miners for work in mines producing strategic metals and minerals. At the present time prospectors who in normal times spend their lives seeking "the yellow metal" in our western hills and deserts, are turning their efforts toward strategic minerals containing tungsten, chromium, manganese, and others. Thus, we see that the existence of all of us including the remote prospector of the west, is being changed by the necessities of war. ●

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o o o

Good teaching is well planned; but do you follow set lesson plans so slavishly that the routine eventually dulls the students' interest? Tomorrow, why not reverse your usual procedure, whatever it is, and do last things first?

o o o

Students in a certain college class make a practice of betting that the first word spoken by a certain teacher each day to his class will be "I." Is your method of greeting always the same? Does "I" loom too large in your teaching?

o o o

Are you influenced too much by a pupil's IQ rating? Does it measure his willingness to work, his personality, his interest in science, or his actual capacity?

o o o

Do you find that the socialized recitation introduces problems of discipline? Do you think that it makes still more confident and assertive the student who needs rather to be made less assertive?

o o o

Are you giving sufficient attention to the timid pupil?

o o o

Do you realize that a nervous teacher makes a nervous and excited class? Be calm.

o o o

Are you a good enough disciplinarian to know when not to see things while at the same time you are insistent on good behavior?

o o o

Do you hurry too much to cover a given assignment? If so, do you give the impression that you are incompetent, or that the class is not studying well? Which is correct?

o o o

Do you realize that what is well taught is easily learned?

o o o

Do you underestimate the importance of drill? Young teachers frequently do. Experienced teachers know how necessary it is.

INDEX to VOLUME VIII
1942

Articles are listed under the author's name. Book reviews are listed under the name of the author of the book. (R) indicates a book review. The name of the reviewer follows in parentheses.

AELRED, SISTER MARY, Seasonal Devices in the Teaching of Biology ... 17
ALLEN, HOLTMAN and MCBEE, "Microbes which Help or Destroy Us," (R) (E. Voss) ... 52
ALMOST A DUTY? ... 33
ALYEA, HUBERT N., Visual Education ... 38
AMERICAN SCIENCE TEACHERS ASSOCIATION TO MEET ... 94
BALINKIN, ISAY A., The World of Color—Color Measurements ... 13
BAYLES, ERNEST E., "Biology for Better Living," (R) (R. T. Hance) ... 51
BELLAMY, D. H., "Experimental Physics," (R) (G. E. Davis) ... 120
BERGER, REV. CHARLES A., Chromosomes and Their Behavior in Cell Division ... 72
BERL, ERNST, Origin of Coal, Oil and Natural Gas and Their Production from Plant Material ... 35
BOS, MARITA, Science Controls Household Pests ... 45
BRAUNGART, D. C. (With G. E. Ott) Colchicine-Induced Polyploidy in the Fruit Fly ... 105
BREWER, GEORGE E. F., Practical Suggestions for the Teaching of Science, Part I ... 15
Part II ... 49
BROOKS, MARVIN M., School Gardens for Applied Science and Victory ... 80
CARLETON and WILLIAMS, "Modern-Life Science," (R) (H. C. Muldoon) ... 84
CARLSON and JOHNSON, "The Machinery of the Body," (R) (E. Voss) ... 21
CARR, C. JELLEFF, Sugar in the Diet of Man ... 40
CASWELL, H. L., "Education in the Elementary School," (R) (K. B. Redman) ... 119
CHERMOCK, RALPH L., Collecting Butterflies, a Scientific Challenge ... 77
COMING IN FUTURE NUMBERS ... 64, 132
COPE, THOMAS D., Some Incidents in the Story of Magnetism ... 66
CORRINGTON, JULIUS D., "Working With the Microscope," (R) (R. T. Hance) ... 21
CREW, HENRY, "Portraits of Famous Physicists," (R) (H. C. Muldoon) ... 85
DAFROSE, SISTER M., "Biology for High Schools" (R) (R. T. Hance) ... 84
DUPUY, R. ERNEST, Non-Science Courses for the Science Teacher ... 34
FISK, HENRY G., Ceramics and the War ... 98
FRENCH, SIDNEY J., "Torch and Crucible," (R) (H. C. Muldoon) ... 51
GOETTING, M. L., "Teaching in the Secondary School," (R) (H. C. Muldoon) ... 119
HAJEK, NORMA, Wetter Water ... 78
HALL, NORRIS F., (and Others), "Acids and Bases," (R) (H. C. Muldoon) ... 51
HAMEL, REV. EDMUND J., The Hierarchy of the Sciences ... 102
HANCE, ROBERT T., Teacher or Subject ... 44
HARRINGTON, LYNN, A Sun-and Earth Model ... 7
HOFFMAN, CHARLES, Enriched Bread ... 108
HYMAN, LIBBIE H., "Comparative Vertebrate Anatomy," (R) (R. T. Hance) ... 118
IDDINS, MAE, "Workbook for Physical Education," (R) (H. C. Muldoon) ... 21
JOHNSON, S., "Young Americans' Dictionary," (R) (K. H. Burkhart) ... 119
LET'S DO BETTER ... 97
LEO, BRO. AUGUST and BRO. CONRAD GABRIEL, "The Physical Universe," (R) (G. E. Davis) ... 120
LEYSON, CAPT. BURR, "It Works Like This," (R) (H. C. Muldoon) ... 21
LONG, WALTER L., Photoelectric Phenomena ... 75
MANNING, ELLIS L., The Rating of Examination Papers in Science ... 112
MAY, TIMOTHY C., Applied Geology ... 19
MCNIFF, WM. T., "College Physics," (R) (G. E. Davis) ... 85
MORE QUESTIONS ... 132
MULDOON, MARY W., School Housekeeping and School Success ... 106
MYER, DWIGHT A., Frequency Modulation ... 114
NATIONAL SCIENCE ESSAY CONTEST AWARDS ... 1
NEELY, W. H., Mr. Cadet Teacher: Do You Know Your High School Science? ... 36
NEW BOOKS ... 21, 51, 84, 118
OFFER, GENEVIEVE, Catholic Mathematicians of the Sixteenth and Seventeenth Centuries ... 9
OTT, G. E. (With D. C. Braungart), Colchicine-Induced Polyploidy in the Fruit Fly ... 105
PAGE, EDWARD L., "Technidata Handbook," (R) (H. C. Muldoon) ... 51
PAGE, WM. H., Fiberglas, a New Basic Material ... 109
PEARSON, CARL A., (With D. G. Ryans), The Performance of Science Teachers on the 1941 National Teacher Examinations ... 2
RAUPP, BARBARA, The Catholic View of Evolution ... 46
RISHWORTH, THOS. D., Transcriptions in Radio Education ... 68
ROMER, ALFRED S., "Man and the Vertebrates," (R) (R. T. Hance) ... 52
ROSAIRE, SISTER M., A Science Society for Honor Students ... 67
ROTH, JOHN M., Suggestions for Projects in Science ... 5
RUNES, D. D., "Dictionary of Philosophy," (R) (J. F. Carroll) ... 118
RUSSELL, E. S., Federal Regulations Which Control or Affect the Purchase of Science Supplies ... 70
RYANS, DAVID G., (With C. A. Pearson) The Performance of Science Teachers on the 1941 National Teacher Examinations ... 2
SHIELDS, BERT A., "Principles of Flight," (R) (A. Kozora) ... 119
"Principles of Aircraft Engines," (R) (A. Kozora) ... 119
SILVA, SISTER MARY, Science Open House ... 79
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